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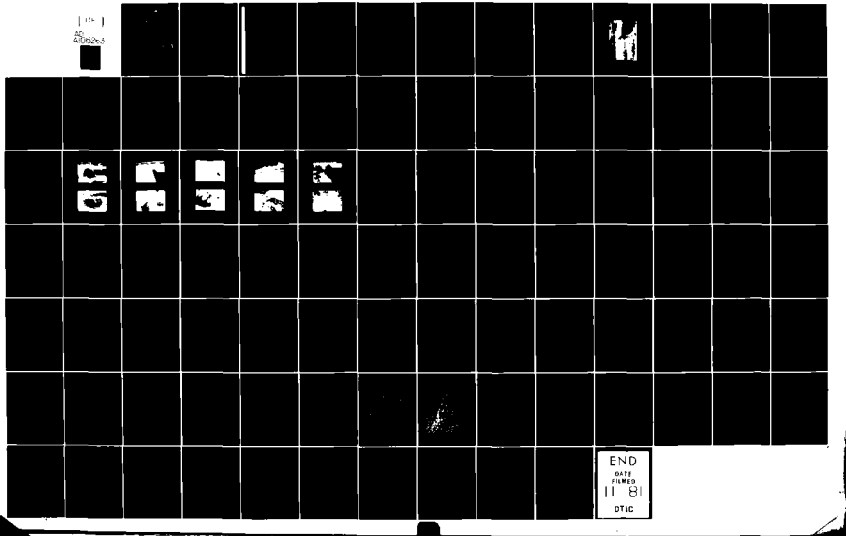

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A106 263
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) Phase I Inspection Report Bronx River Dam (North) Lower Hudson River, Bronx County, NY Inventory No. 1500	5. TYPE OF REPORT & PERIOD COVERED Phase I Inspection Report National Dam Safety Program
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) GRANVILLE KESTER, JR.	8. CONTRACT OR GRANT NUMBER(s) DACW51-81-C-0010
9. PERFORMING ORGANIZATION NAME AND ADDRESS Michael Baker, Jr. Inc. 4301 Dutch Ridge Road Box 280 Beaver, PA 15009	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Department of the Army 26 Federal Plaza New York District, CofE New York, New York 10287	12. REPORT DATE 14 August 1981
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Department of the Army 26 Federal Plaza New York District, CofE New York, NY 10287	15. SECURITY CLASS. (of this report) UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

LEVEL 4

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

National Dam Safety Program. Bronx River Dam (Inventory Number NY. 1500), Lower Hudson River Basin, Phase I Inspection Report.

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety
National Dam Safety Program
Visual Inspection
Hydrology, Structural Stability
Bronx River Dam (North)
Bronx County
Lower Hudson River Basin

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the personnel organization.

Examination of available documents and a visual inspection of the dam and appurtenant structures did not reveal any conditions which constitute an immediate hazard to human life or property.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Using the Corps of Engineers' screening criteria, it has been determined that the dam would be overtopped for all storms exceeding approximately 10 percent of the Probable Maximum Flood (PMF). Therefore, the spillway is adjudged as "seriously inadequate," and the dam is assessed as "unsafe, non-emergency."

Structural stability analyses based on available information, indicate that the factors of safety against overturning are generally low, and the locations of the resultants fall outside of the middle 1/3. When the dam is subjected to severe loading conditions such as a PMF event, the factor of safety falls below the critical level.

Therefore, it is recommended that, within three months of owner notification, detailed hydrologic and hydraulic investigations of the structure should be undertaken to more accurately determine the site-specific characteristics of the watershed and their effects upon the overtopping potential of the dam. At the same time, further analyses of the structural stability of the dam should be performed. The results of these investigations and analyses will determine the appropriate remedial measures. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Around-the-clock surveillance must also be provided during these periods.

Current inspection and maintenance procedures by the owner are adequate but need to be documented. Monitoring of the reservoir levels should be expanded to include readings during peak flow periods.

The following remedial measures must be completed within one year:

1. Fill the voids beneath the left training wall and protect with riprap.

2. Fill, compact, and seed the area of erosion behind the left training wall.

3. Repair the mortar joints on the crest of the dam.

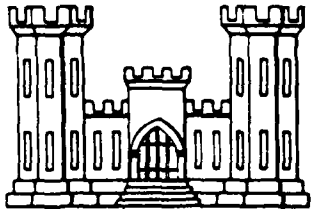
4. Clear the debris from the spillway crest.

LOWER HUDSON RIVER BASIN

BRONX RIVER DAM

BRONX COUNTY, NEW YORK
INVENTORY NO. N.Y. 1500

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



NEW YORK DISTRICT CORPS OF ENGINEERS

AUGUST 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BRONX RIVER DAM
I.D. No. NY 1500
DEC DAM No. 215C-4452, LOWER HUDSON RIVER BASIN
BRONX COUNTY, NEW YORK

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Bronx River Dam (I.D. No. NY 1500)
State:	New York
County:	Bronx
Stream:	Bronx River
Date of Inspection:	7 March 1981

ASSESSMENT

Examination of available documents and a visual inspection of the dam and appurtenant structures did not reveal any conditions which constitute an immediate hazard to human life or property.

Using the Corps of Engineers' screening criteria, it has been determined that the dam would be overtopped for all storms exceeding approximately 10 percent of the Probable Maximum Flood (PMF). Therefore, the spillway is adjudged as "seriously inadequate," and the dam is assessed as "unsafe, non-emergency."

Structural stability analyses based on available information, indicate that the factors of safety against overturning are generally low, and the locations of the resultants fall outside of the middle 1/3. When the dam is subjected to severe loading conditions such as a PMF event, the factor of safety falls below the critical level.

Therefore, it is recommended that, within three months of owner notification, detailed hydrologic and hydraulic investigations of the structure should be undertaken to more accurately determine the site-specific characteristics of the watershed and their effects upon the overtopping potential of the dam. At the same time, further analyses of the structural stability of the dam should be performed. The results of these investigations and analyses will determine the appropriate remedial measures. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Around-the-clock surveillance must also be provided during these periods.

Current inspection and maintenance procedures by the owner are adequate but need to be documented. Monitoring of the reservoir levels should be expanded to include readings during peak flow periods.

The following remedial measures must be completed within one year:

1. Fill the voids beneath the left training wall and protect with riprap.

2. Fill, compact, and seed the area of erosion behind the left training wall.

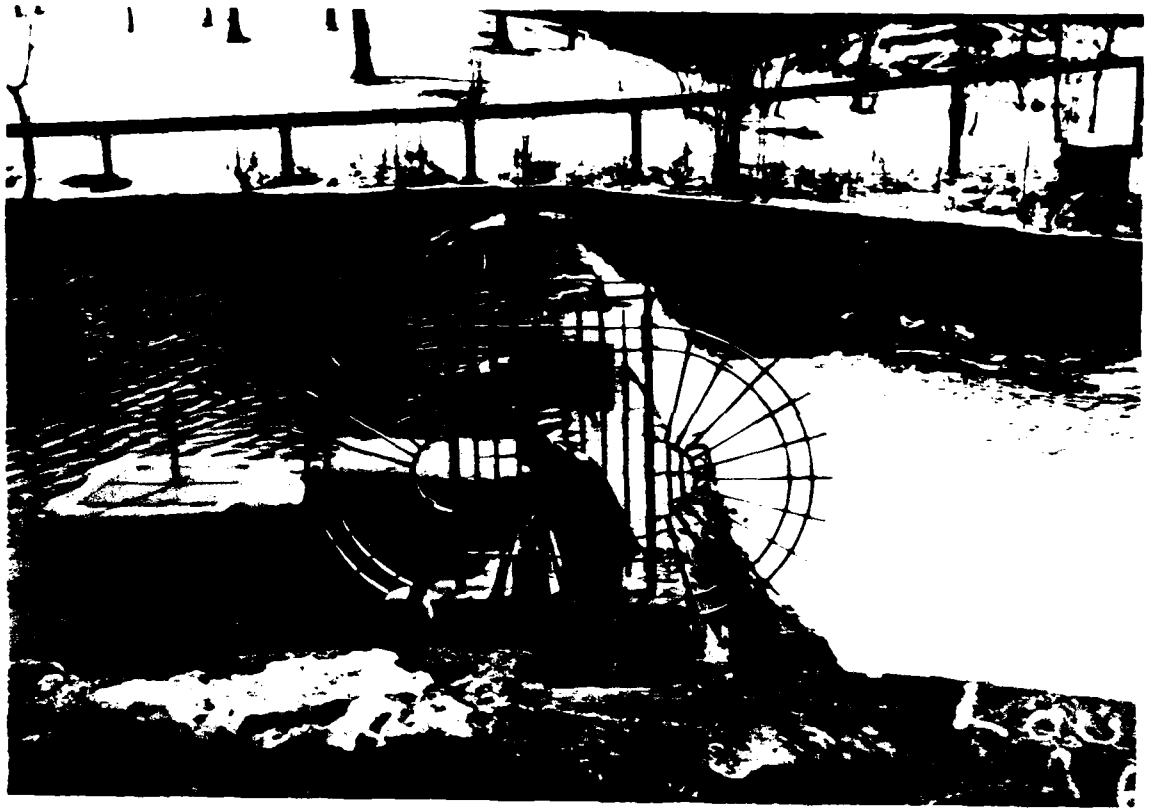
3. Repair the mortar joints on the crest of the dam.

4. Clear the debris from the spillway crest.

SUBMITTED: _____
Granville Kester, Jr., P.E.
Vice President
MICHAEL BAKER, JR. of New York, INC.

APPROVED: _____
Colonel W.M. Smith, Jr.
New York District Engineer

DATE: 14 Aug 81



Overall View of Dam
Bronx River Dam
I.D. No. NY 1500
7 March 1981

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BRONX RIVER DAM
I.D. No. NY 1500
DEC DAM No. 215C-4452
LOWER HUDSON RIVER BASIN
BRONX COUNTY, NEW YORK

SECTION 1: PROJECT INFORMATION

1.1 GENERAL

a. Authority - The Phase I Inspection reported herein was authorized by the Department of the Army, New York District, Corps of Engineers, to fulfill the requirements of the National Dam Inspection Act, Public Law 92-367.

b. Purpose of Inspection - This inspection was conducted to evaluate the existing conditions of the dam, to identify deficiencies and hazardous conditions, to determine if these deficiencies constitute hazards to life and property, and to recommend remedial measures where required.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam - Bronx River Dam is a stone and mortar structure 17.7 feet high[1] and 121.5 feet long. The right section of the dam[2] has a crest width of about 5.5 feet, an upstream slope of 1H:5.9V (Horizontal to Vertical), and a downstream slope of 1H:4.9V.

The spillway is a broad-crested, concrete weir with a breadth of 4 feet parallel to the flow. The spillway starts 32 feet from the right abutment and extends 89.5 feet to the stone wall on the left abutment. The upstream side of the spillway is an 8-inch high vertical face. The downstream side of the spillway is on 1H:5.3V slope down to a 1-foot long step that extends

[1]Measured from the invert of the outlet pipe at the downstream toe to minimum crest of dam.
[2]Looking downstream.

across the width of the spillway about 3 feet below the spillway crest. From this step, water cascades over large rocks (about 1 to 3 feet square), mortared together to form a rough 1H:2V slope. Water drops from these stones and into the river at the toe of the dam. The spillway crest is about 3.4 feet lower than the elevation of the right side of the dam. The left side of the spillway is against a 2-foot wide vertical mortared stone wall that is about 3.5 feet higher than the spillway crest.

A 3-foot diameter iron pipe acts as the outlet for the dam. The valve that controls the flow through this pipe is located on a 7-foot wide masonry deck, 16 feet upstream from the right side of the dam. The outlet of this pipe is about 10 feet downstream from the crest of the spillway.

b. Location - Bronx River Dam is located on the Bronx River at the south side of the Bronx City Zoo in New York City, New York. The dam is in Bronx County, New York. The coordinates for the dam are N 40° 50.6' and W 73° 52.6'. The dam can be found on the Central Park, New York USGS 7.5 minute topographic quadrangle. A location map is included in this report in Appendix E.

c. Size Classification - Bronx River Dam is 17.7 feet high, and the reservoir storage capacity at the minimum top of dam (elevation 33.4 feet M.S.L. is 108 acre-feet. Therefore, the dam is in the "small" size category as defined by the Recommended Guidelines for Safety Inspection of Dams (Reference 13, Appendix D).

d. Hazard Classification - The dam is in a highly urbanized area. There are many apartment houses and businesses located on the river banks downstream of the dam. A playground is located about 200 feet downstream of the dam. In the event of dam failure, loss of life and significant economic damage to downstream structures are considered likely. Therefore, Bronx River Dam is considered to be in the "high" hazard category, as defined by the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams is a function of location only, and is not related to its stability or probability of failure.

e. Ownership - Bronx River Dam is owned by New York City, New York. The person in charge of the dam is David Cole, Deputy Director of Operations, New York Zoological Society, Southern Boulevard at 185th Street, Bronx, New York 10460 (telephone 212-220-5100).

f. Purpose of Dam - Bronx River Dam is used for recreation.

g. Design and Construction History - According to available information, the dam was probably built around 1900. No other information about the design or construction history was available.

h. Normal Operating Procedures - The reservoir level is usually maintained near the crest of the spillway at elevation 30.0 feet M.S.L. According to the owner's representative, the valve controlling the outlet pipe is opened, and the reservoir is drained every two or three years.

1.3 PERTINENT DATA

a. Drainage Area (Square Miles) - 36.36

b. Discharge at Dam (c.f.s.) -

Spillway Capacity (at Minimum Top of Dam Elev. 33.4 ft. M.S.L.)	1571.0
Reservior Drain at Normal Pool	123.0

c. Elevations (Feet Above M.S.L.)[3] -

Minimum Top of Dam	33.4
Normal Pool (Spillway Crest)	30.0
Outlet Pipe at Toe of Dam	15.7

d. Reservoir Surface (Acres) -

Top of Dam (Elev. 33.4 ft. M.S.L.)	17.70
Spillway Crest (Elev. 30.0 ft. M.S.L.)	12.48

e. Reservoir Storage Capacity (Acre-Feet) -

Top of Dam (Elev. 33.4 ft. M.S.L.)	108.0
Spillway Crest (Elev. 30.0 ft. M.S.L.)	58.0

[3]All elevations are referenced to the spillway crest, elev. 30.0 ft. M.S.L., estimated from the USGS 7.5 minute topographic quadrangle, Central Park, New York.

f. Dam -

Type: Stone and mortar.	
Length (Feet)	121.5
Height (Feet)	17.7
Top Width (Feet)	5.5
Side Slopes - Upstream	1H:5.9V
Downstream	1H:4.9V

Cut-off - No information available.

g. Spillway -

Type: Concrete broad-crested weir	
Crest Length Perpendicular to Flow (Feet)	89.5
Crest Width Parallel to Flow (Feet)	4.0
Crest Elevation (ft. M.S.L.)	30.0

h. Reservoir Drain -

Type: One 3-foot diameter iron pipe that extends through the base of the dam on the right side.

Control: Manual control valve operated from the stone and masonry deck that extends upstream from the right side of the dam.

SECTION 2: ENGINEERING DATA

2.1 GEOLOGY

The Bronx River Dam is located in the "New England Upland Lands" physiographic province of New York State. This province is geologically complex and characteristically composed of igneous and metamorphic rocks which have been tectonically disturbed by a number of thrust and normal faults.

Bedrock in the immediate vicinity of the dam is represented by Ordovician and Precambrian rocks. The Ordovician rocks are composed of hornblende; the Manhattan Formation, undifferentiated schist to gneiss; and the Inwood Marble. The Precambrian rocks consist of the Fordham Gneiss, undifferentiated, and the Yonkers Gneiss. The State of New York has mapped a fault within 2 miles of the dam site, the contact of which is uncertain. That section of the fault in the vicinity of the dam may be a possible root zone of the taconic nappes and other possible taconic thrusts.

2.2 SUBSURFACE INVESTIGATION

Subsurface information was unavailable for reference as a part of this investigation. Soil on the left abutment consists of stony loam with angular-to-rounded rock fragments and gravel and a fractional amount of cobble size rocks. The right abutment of the dam consists of chlorite mica schist with nearly vertical fractures orientated upstream to downstream. Boulders used for the dam (at the left end where debris diverts the water from cascading over the spillway) consist of quartz mica schist material and average approximately 3 feet in size.

2.3 DAM AND APPURTENANT STRUCTURES

The dam is a stone masonry structure with an upstream slope of 1H:5.9V (Horizontal to Vertical), a crest width of 5.5 feet, and a downstream slope of 1H:4.9V. The spillway is an 89.5-foot broad-crested weir beginning 32 feet from the right abutment. The spillway discharges into the natural stream channel.

The control valve for the 3-foot diameter iron outlet pipe is located on a 7-foot wide stone masonry deck, 16 feet upstream from the crest of the dam.

2.4 CONSTRUCTION RECORDS

Construction records were unavailable for this investigation.

2.5 OPERATING RECORDS

No formal operation records are maintained by the City of New York. The control gate is opened, and the reservoir is drained every two or three years. Maintenance is performed as needed.

2.6 EVALUATION OF DATA

The background information collected during this investigation was obtained verbally from Mr. David Cole, Deputy Director of Operations, New York Zoological Society. Available engineering data are considered adequate and reliable for Phase I Inspection purposes.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General - The visual inspection of Bronx River Dam was conducted on 7 March 1981. The weather was cloudy and the temperature was around 35° to 40° F. The ground surface was generally frozen and covered with a light dusting of snow. At the time of inspection, the reservoir level was at 30.3 feet M.S.L. Deficiencies found during the inspection will require remedial treatment. A Field Sketch of conditions found during the inspection is included in Appendix E. The complete Visual Inspection Checklist is presented as Appendix B.

b. Spillway - The spillway is a 4-foot wide concrete, broad-crested weir extending 89.5 feet across the length of the dam. A 3-inch water flow over the spillway crest at the time of inspection made visual observation difficult. There were no signs of cracking or crest settlement at the time of inspection. There was, however, some debris on the spillway crest partially obstructing the flow. Near the left abutment, debris almost stopped the water flow over the spillway. At this spot, the downstream face of the spillway appeared to be intact, and the mortar joints between these stones showed no signs of deterioration or spalling. Water discharges over the downstream face of the spillway into the natural river channel at the toe of the dam. The channel is lined with riprap. The left side of the spillway is bound by a 2-foot thick mortared stone wall on the left abutment. This wall was partially undercut at the wall base about 15 feet downstream of the spillway. The area behind this wall was eroded to a depth of almost 3 feet. There were no problems observed at the junction of the spillway and the right side of the dam. There was a 1-foot high and 18-inch wide concrete curb and spider fence on the left side of the spillway crest.

c. Dam - Bronx River Dam is a masonry structure. Both the upstream and downstream faces are made of stone and mortar walls, and the top is capped by a rough mortared surface. There was some cracking observed on this top surface. There is a 1-foot high and 18-inch wide concrete curb and spider fence on the right side of the dam. There were a

few areas where weeds have grown between the joints of the stones on the upstream side near the water surface and on the downstream slope near the spillway. There was also an area of seepage observed about 3 feet above the toe of the wall on the right downstream side of the dam near the spillway. The rate of flow from this seep was estimated to be less than 0.5 g.p.m. and was flowing clear, although there was some iron staining at the area of this seep. There were no problems observed at the junction of the dam and the right abutment.

d. Outlet Works - A 3-foot diameter iron pipe extends through the right side of the dam. This pipe is controlled by a gate valve operated from the masonry deck extending upstream from the right side of the dam. According to the owner's representative, this valve is operable and can be used to dewater the reservoir.

e. Downstream Channel - The downstream channel below the spillway is a 70-foot to 100-foot wide river channel bound by vertical mortared stone walls on each side. There is a playground on the right abutment about 200 feet downstream of the dam. A stone bridge crosses the channel about 400 feet below the dam. There are many buildings built right on the river walls on both banks.

f. Reservoir - The reservoir slopes are mostly flat with some bare rock outcroppings. There were no signs of instability, and sedimentation was not reported to be a problem.

3.2 EVALUATION

The visual inspection revealed several deficiencies in this structure. The following were noted:

1. A clear seep (less than 0.5 g.p.m.) was observed exiting the dam 3 feet above the toe and 10 feet right from the outlet channel.

2. The left training wall is under cut about 15 feet downstream from the spillway.

3. An area of erosion was observed behind the left training wall.

4. Weeds are growing in the mortar joints along the crest of the dam.

5. Debris was located on the upstream crest of the spillway.

SECTION 4: OPERATION AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

There are no formal written instructions for operating the reservoir. The normal water surface elevation is near the spillway crest elevation of 30.0 feet M.S.L. Water can be released to the downstream area through a 3-foot diameter iron pipe. This valve is operated from the masonry peninsula extending upstream from the toe of the dam.

4.2 MAINTENANCE OF DAM

Dam maintenance is the responsibility of the City of New York. There is no formal maintenance schedule for the dam.

4.3 WARNING SYSTEM

At the time of the inspection, there was no warning system or emergency action plan in operation.

4.4 EVALUATION

Past maintenance of the dam and operating facilities appear to have been adequate, but the past activities have gone undocumented. A checklist should be compiled by the owner's representative to document the findings made during the periodic inspections and the maintenance items completed. A warning system and emergency action plan should be developed and put into operation.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 DRAINAGE AREA CHARACTERISTICS

The drainage area is mainly urbanized with some rural areas in the uppermost portion of the watershed. Some upland storage exists in the form of flat areas and small lakes. The total drainage area is 36.36 square miles.

5.2 ANALYSIS CRITERIA

The drainage area considered in this analysis does not include the drainage areas for Kensico Reservoir; White Plains Reservoirs 1 and 2; and the Grassy Sprain Reservoir, located in the upper reaches of the Bronx River, because their entire inflows are diverted for municipal water supply.

The hydraulic capacity of the dam, reservoir, and spillway was assessed by utilizing the U.S. Army Corps of Engineers Flood Hydrograph Package HEC-1 DB. The hydrologic characteristics of the basin (specifically the Snyder's unit hydrograph parameters) were average values derived from the Hydrologic Flood Routing Model for Lower Hudson River Basin, Bronx River (Reference 14, Appendix D). The runoff hydrograph was developed by simulating the Standard Project Storm (SPS). Total SPS rainfall and excess were used to approximate the SPS flow at West Farms, approximately 2500 feet below Bronx River Dam, of 12,845 c.f.s. Using tp = 10.0 hr.; Cp = 0.57, initial rainfall loss of 2.0 inch; and a constant loss rate of 0.3 inches per hour, a flow of 13,060 c.f.s. was obtained. This flow is within 2 percent of the SPS flow value calculated for this point in the Hydrologic Flood Routing Model for Lower Hudson River Basin, Bronx River. The PMP rainfall amounts were then substituted for the SPS amounts. The PMF and 1/2 PMF were then routed through the reservoir and dam.

5.3 SPILLWAY CAPACITY

The spillway capacity at the minimum top of dam is 1571 c.f.s. There is no auxiliary or emergency spillway.

5.4 RESERVOIR CAPACITY

The storage capacity of Bronx River Dam at normal pool is 58 acre-feet. The storage capacity of the reservoir at the minimum top of dam is 108 acre-feet. Therefore, the flood control storage of the reservoir between the spillway crest and the top of dam is 50 acre-feet. This

volume represents a total runoff of 0.03 inches from the drainage area.

5.5 FLOODS OF RECORD

The maximum flow at West Farms, approximately 2500 feet downstream from Bronx River Dam, was 3698 c.f.s. during Agnes in 1972. This should have overtopped the dam by approximately 1 foot. The owner, however, was unable to confirm this.

5.6 OVERTOPPING POTENTIAL

The maximum capacity of the spillway is 1571 c.f.s. before overtopping would occur. The peak outflows of the PMF and 1/2 PMF are 20,405 c.f.s. and 10,207 c.f.s., respectively. Therefore, the spillway is capable of passing 10 percent of the PMF before overtopping would occur.

5.7 RESERVOIR EMPTYING POTENTIAL

The reservoir can be drawn down by means of a 3-foot diameter outlet pipe. Neglecting inflow, the reservoir can be drawn down from normal pool in approximately 6.5 hours. This is equivalent to an approximate drawdown rate of 1.5 feet per hour, based on the hydraulic height measured from normal pool divided by the time to dewater the reservoir.

5.8 EVALUATION

Bronx River Dam is a "small" size - "high" hazard dam requiring the spillway to pass a flood in the range of the 1/2 PMF to PMF. The PMF and 1/2 PMF were routed through the watershed and dam. It was determined that the spillway is capable of passing 10 percent of the PMF before overtopping the dam. Structural stability analyses based on available information, indicate that factors of safety against overturning are less than desirable. When the dam is subjected to severe loading conditions such as the 1/2 PMF or PMF events, the factors of safety fall to critical levels. Therefore, the spillway is judged to be "seriously inadequate."

Conclusions pertain to present conditions, and the effect of future development on the hydrology has not been considered.

SECTION 6: STRUCTURE STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - No signs of instability were noted during the field inspection. Minor problems observed which could affect the stability of the structure include:

1. A clear seep (less than 0.5 g.p.m.) was observed exiting the dam 3 feet above the toe and 10 feet right from the outlet channel.

2. The left training wall is undermined approximately 15 feet downstream from the spillway.

3. An erosion channel has formed behind the left training wall. This channel is as deep as 3 feet at places.

b. Design and Construction Data - Design and construction data were unavailable.

c. Operating Records - The owner's representative reported that the reservoir was drawn down several times. No additional operational information is available.

d. Post Construction Changes - Information concerning post construction changes is unavailable.

6.2 STABILITY ANALYSIS

The results of any previous stability analyses were unavailable for reference during this evaluation. A structural stability analysis was conducted for a typical spillway section. The cases analyzed and respective results are as follows:

Case	Description of Loading Conditions
1	Normal operating conditions with reservoir level at the spillway crest, full uplift, and 2.2 feet of tailwater.
2	Same as Case 1 with the additional ice loading of 5000 pounds per lineal foot.
3	Reservoir level during 1/2-PMF, full uplift, with a tailwater of 7.5 feet.
4	Reservoir level during the PMF, full uplift, with a tailwater of 10.0 feet.

Case	Factor of Safety Overturning	Sliding	Location of Resultant From Toe (ft.)
1	2.06	7.10	7.78
2	1.26	3.86	3.08
3	1.09	3.44	1.96
4	0.99	3.23	-0.41

Notes: Location of middle 1/3 is 10.67 to 5.33 feet from the downstream toe.

A negative sign (-) above indicates that the location of the resultant is downstream from the toe.

A value of 2 ksf was used as a conservative approximation of the shear strength of weathered rock.

In all cases, the factors of safety against sliding exceed the recommended value of 3. The factors of safety against overturning are low, and the resultants fall outside of the middle 1/3 (except for Case 1 - Normal Pool). Therefore, the dam is considered unsafe against overturning. However, the structure withstood normal loading conditions in the past without apparent damage, and the analyses may not indicate the true field conditions or proper loading conditions. Since overturning during the SDF would result in a probable loss of life downstream of the dam, a detailed stability analysis of the dam should be performed by a qualified engineering firm within three months of owner notification.

6.3 SEISMIC STABILITY

Bronx River Dam is located in Seismic Zone 1 which presents no hazard from earthquakes, according to the Recommended Guidelines for Safety Inspection of Dams by the Department of the Army, Office of the Chief of Engineers. This determination is contingent on the requirements that static stability conditions are satisfactory, and conventional safety margins exist. As indicated in Paragraph 6.2, the dam has low factors of safety against overturning. If the requested additional analysis does not indicate conventional safety margins against overturning, additional analysis of the effects of earthquakes on the structural stability should be performed.

SECTION 7: ASSESSMENT/RECOMMENDATIONS

7.1 ASSESSMENT

a. Safety - Examination of available documents and visual inspections of Bronx River Dam did not reveal any conditions which constitute an immediate hazard to human life or property.

Using the Corps of Engineers' screening criteria for review of spillway adequacy, it has been determined that the dam would be overtopped for all storms exceeding approximately 10 percent of the PMF. The overtopping of the dam could result in dam failure, increasing the hazard to loss of life downstream. Therefore, the spillway is adjudged as "seriously inadequate," and the dam is assessed as "unsafe, non-emergency."

The stability analyses of the dam performed for this investigation indicate that the factors of safety against overturning may be inadequate.

b. Adequacy of Information - The information available and the observations and measurements made during the visual inspection are considered sufficient for this Phase I Inspection Report.

c. Need for Additional Investigation - Detailed hydrologic and hydraulic investigations of the watershed and reservoir area are considered necessary to more accurately determine the overtopping potential of the dam. After the in-depth hydrologic/ hydraulic investigations have been completed, remedial measures must be initiated to provide spillway capacity sufficient to discharge the outflow from the 1/2 PMF event. A detailed stability analysis of the dam is considered necessary to determine actual stability conditions.

d. Urgency - The detailed hydrologic and hydraulic and stability investigations must be initiated within three months of notification to the owner. Within one year, remedial measures resulting from these investigations must be initiated and completed during the following year. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Around-the-clock surveillance must also be provided during these periods.

7.2 RECOMMENDED MEASURES

The regular inspections and maintenance procedures presently conducted by the owner's representative appear to be adequate, although some form of documentation is needed. A thorough checklist should be compiled by the owner's representative and completed during each inspection. Maintenance items should be completed annually. Monitoring of the reservoir level should be expanded to include reservoir levels above normal pool.

A formal warning system and emergency action plan should be developed and put into action as soon as possible.

The following remedial measures must be completed within one year:

1. Fill beneath the left training wall and protect with riprap.

2. Fill, compact, and seed the area of erosion behind the left training wall.

3. Repair the mortar joints on the crest of the dam.

4. Clear the debris from the spillway crest.

APPENDIX A

PHOTOGRAPHS

CONTENTS

Note: Photos were taken 7 March 1981.

BRONX RIVER DAM

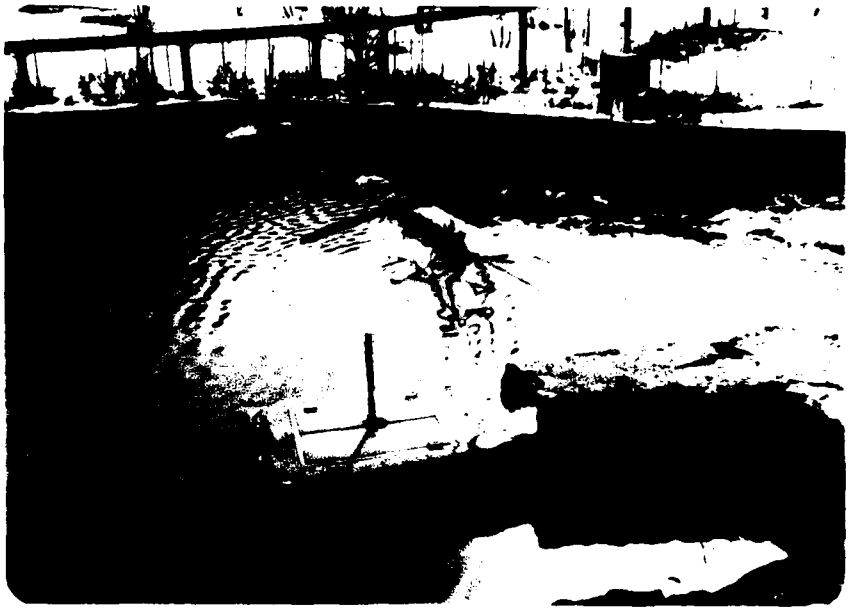


Photo 1. View of Upstream Side of Dam
Outlet Gate Valve Stem Located in Foreground
7 March 1981

Photo 2. View of Downstream Face of Dam
Outlet Pipe Located at Bottom Left of Photo in Spillway Discharge Area
7 March 1981

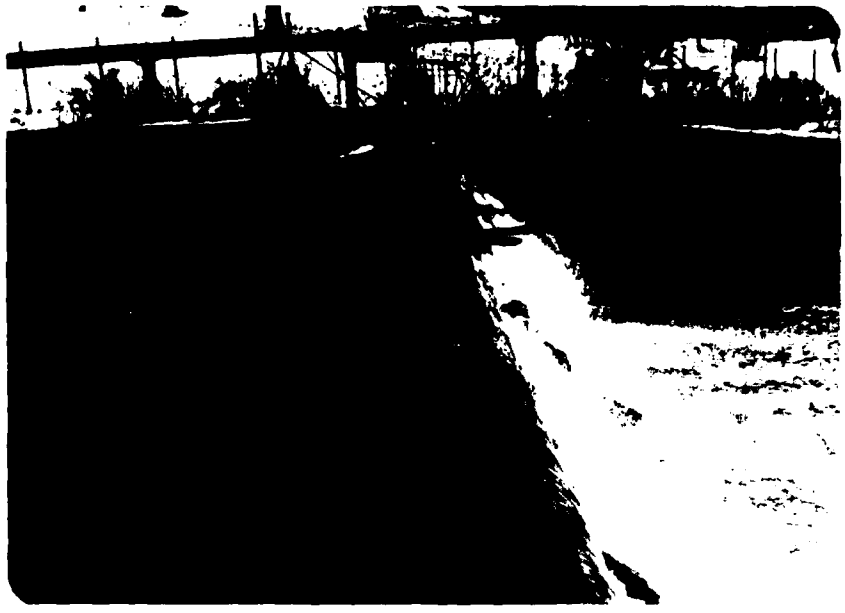


Photo 3. View Across Crest of Spillway from Right Training Wall
7 March 1981

Photo 4. View Across Crest of Spillway From Left Abutment
7 March 1981

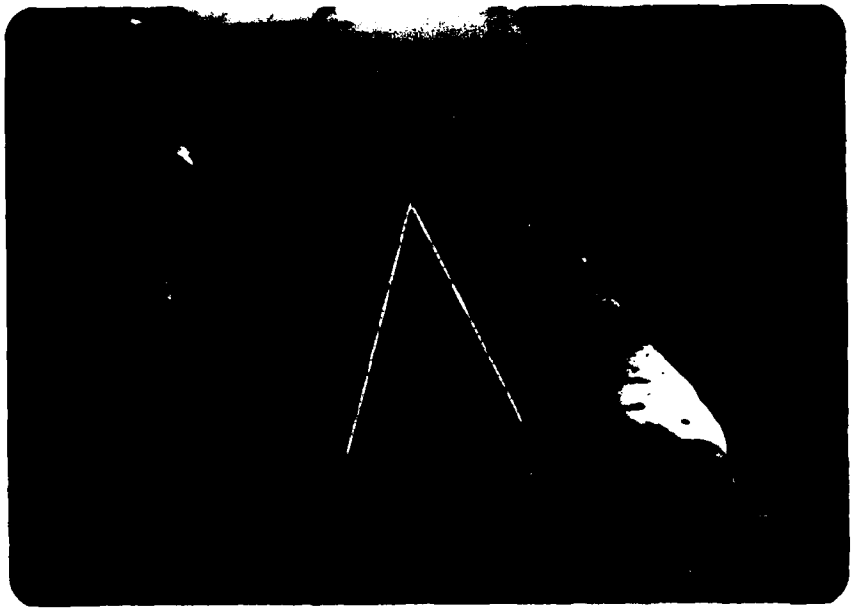


Photo 5. View of Outlet Valve Stem
7 March 1981

Photo 6. View Looking Downward at Outlet Pipe
7 March 1981

Photo 7. View of Left Training Wall of Spillway
7 March 1981

Photo 8. View of Erosion Behind Left Training Wall of Spillway
7 March 1981

Photo 9. View Across Downstream Face of Spillway Right Abutment
Note Staining in Bottom Center of Photo on Downstream Face of Dam
7 March 1981

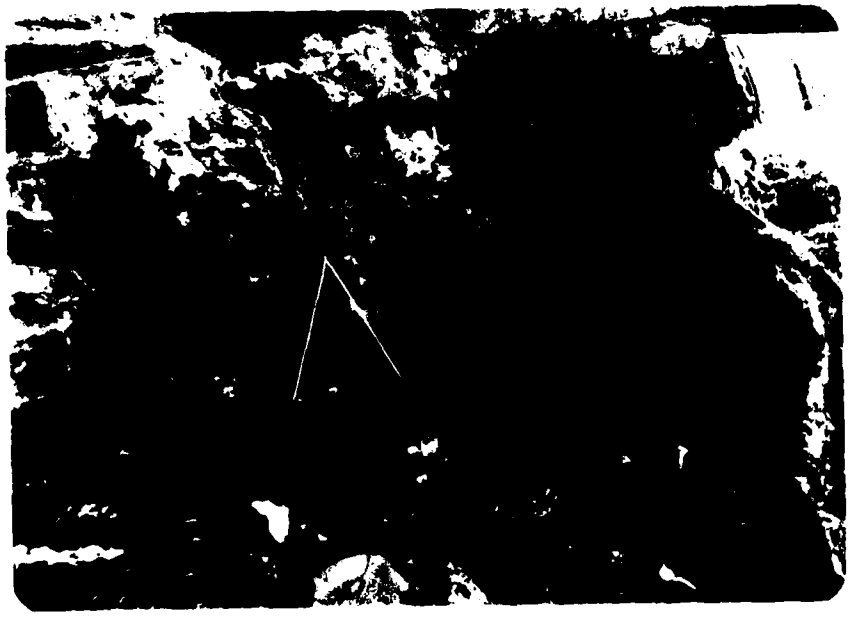


Photo 10. View of Minor Seepage Through Dam
(See Photo 9 for Location)
7 March 1981

APPENDIX B

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam Bronx River Dam

Fed. I.D. # NY 1500 DEC Dam No. 215C-4452

River Basin Lower Hudson

Location: Town Bronx County Bronx

Stream Name Bronx River

Tributary of East River

Latitude (N) 40° 50.60' Longitude (W) 73° 52.59'

Type of Dam Masonry and concrete

Hazard Category High

Date(s) of Inspection 7 March 1981

Weather Conditions Cloudy, 35° - 40°

Reservoir Level at Time of Inspection 30.3 ft. M.S.L.

b. Inspection Personnel James Ulinski, Anthony Klimek, Steve Lockington

c. Persons Contacted (Including Address & Phone No.) 212-220-5100

David Cole, Deputy Director of Operations

New York Zoological Society

Southern Blvd. at 185th Street

Bronx, NY 10460

d. History:

Date Constructed About 1900 Date(s) Reconstructed

Designer Unknown

Constructed By Unknown

Owner City of New York, New York

2) Embankment N/A

a. Characteristics

(1) Embankment Material _____

_____

(2) Cutoff Type _____

_____

(3) Impervious Core _____

_____

(4) Internal Drainage System _____

_____

(5) Miscellaneous _____

_____

b. Crest

(1) Vertical Alignment _____

_____

(2) Horizontal Alignment _____

_____

(3) Surface Cracks _____

_____

(4) Miscellaneous _____

_____

c. Upstream Slope

(1) Slope (Estimate) (V:H) _____

_____

(2) Undesirable Growth or Debris, Animal Burrows _____

_____

(3) Sloughing, Subsidence, or Depressions _____

_____

_____

(4) Slope Protection _____

_____

_____

(5) Surface Cracks or Movement at Toe _____

_____

d. Downstream Slope

(1) Slope (Estimate - V:H) _____

_____

(2) Undesirable Growth or Debris, Animal Burrows _____

_____

_____

(3) Sloughing, Subsidence or Depressions _____

_____

_____

(4) Surface Cracks or Movement at Toe _____

_____

(5) Seepage _____

_____

_____

(6) External Drainage System (Ditches, Trenches, Blanket) _____

_____

_____

(7) Condition Around Outlet Structure _____

_____

(8) Seepage Beyond Toe _____

e. Abutments - Embankment Contact _____

(1) Erosion at Contact _____

(2) Seepage Along Contact _____

3) Drainage System

a. Description of System None

b. Condition of System Not applicable

c. Discharge from Drainage System Not applicable

4) Instrumentation (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.) None

5) Reservoir

a. Slopes Slopes are steep to mild.

b. Sedimentation Sedimentation was not reported to be a problem.

c. Unusual Conditions Which Affect Dam None observed

6) Area Downstream of Dam

a. Downstream Hazard (No. of Homes, Highways, etc.) Downstream area is very developed, consisting of apartments and businesses. A playground is located 200 ft. downstream.

b. Seepage, Unusual Growth Seepage 10 ft. from the outlet conduit was observed to be clear with less than 0.5 gpm rate of flow.

c. Evidence of Movement Beyond Toe of Dam No movement evidenced.

d. Condition of Downstream Channel Bridge located downstream. The channel has a masonry/riprap bottom and mortared masonry sides.

7) Spillway(s) (Including Discharge Conveyance Channel)

a. General The spillway is located 34 ft. from the right abutment, and consists of a concrete broad-crested weir 89.5 ft. wide (perpendicular to flow), and 4 ft. long (parallel to flow).

b. Condition of Service Spillway The spillway appears to be in fair condition. In some places, debris has piled up behind the spillway.

c. Condition of Auxiliary Spillway None

d. Condition of Discharge Conveyance Channel The discharge conveyance channel has minor growth and appeared to be in fair condition.

8) Reservoir Drain/Outlet

Type: Pipe X Conduit _____ Other _____

Material: Concrete _____ Metal _____ Other Iron

Size: 36 inch Length 30 ft. (estimated)

Invert Elevations: Entrance Unknown

Exit 15.68 ft.

Physical Condition (Describe): Unobservable X

Material: Iron

Joints: _____ Alignment _____

Structural Integrity: _____

Hydraulic Capability: _____

Means of Control: Gate _____ Valve X Uncontrolled _____

Operation: Operable X Inoperable _____ Other _____

Present Condition (Describe): At the time of inspection, the valve was open and the reservoir was being lowered.

9) Structural

a. Concrete Surfaces Dam is mortared rockfill and in fair condition. Left side of dam is a mortared stone wall about 2 ft. wide and 3.5 ft. high.

b. Structural Cracking No problems observed.

c. Movement - Horizontal & Vertical Alignment (Settlement) No movement was observed.

d. Junctions with Abutments or Embankments Right abutment consists of chlorite mica schist with vertical fractures. Erosion has occurred behind the stone wall on the left abutment.

e. Drains - Foundation, Joint, Face None observed.

f. Water Passages, Conduits, Sluices Outlet conduit appeared to be in fair condition and was operating at the time of inspection.

g. Seepage or Leakage Clear seepage (less than 0.5 gpm) was observed 10 ft. from the outlet conduit, about 3 ft. above the toe on the downstream side of the dam and ndear the spillway.

h. Joints - Construction, etc. No problem observed.

i. Foundation Unobservable

j. Abutments Erosion has occurred behind the stone wall of the left abutment.

k. Control Gates Unobservable

l. Approach & Outlet Channels Due to recent precipitation, the upstream channel was unobservable. The outlet channel was in fair condition.

m. Energy Dissipators (Plunge Pool, etc.) None

n. Intake Structures Unobservable

o. Stability No problems observed.

p. Miscellaneous

10) Appurtenant Structures (Power House, Lock, Gatehouse, Other)

a. Description and Condition None

APPENDIX C

HYDROLOGIC/HYDRAULIC DATA AND COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject BRONX RIVER DAM S.O. No.
APPENDIX C Sheet No. of
HYDROLOGIC / HYDRAULIC CALC. Drawing No.
Computed by Checked by Date

SUBJECT	PAGE

CHECK LIST FOR DAMS
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

AREA-CAPACITY DATA:

		Elevation (ft.)	Surface Area (acres)	Storage Capacity (acre-ft.)
1)	Top of Dam	33.4	17.70	108
2)	Design High Water (Max. Design Pool)	----	-----	--
3)	Auxiliary Spillway Crest	----	-----	--
4)	Pool Level with Flashboards	----	-----	---
5)	Service Spillway Crest	30.0	12.48	58

DISCHARGES

		Volume (cfs)
1)	Average Daily	38
2)	Spillway @ Maximum High Water - Top of Dam -	1570
3)	Spillway @ Design High Water	--
4)	Spillway @ Auxiliary Spillway Crest Elevation	--
5)	Low Level Outlet	123
6)	Total (of all facilities) @ Maximum High Water	1693
7)	Maximum Known Flood	Unknown
8)	At Time of Inspection	36

CREST: ELEVATION: 33.4 ft.

Type: Masonry

Width: 5.5 ft. Length: 121.5 ft.

Spillover Broad crested weir

Location 34 ft. from right abutment

SPILLWAY:

SERVICE		AUXILIARY
30.0 ft.	Elevation	None
Broad crested weir	Type	----
89.5 ft.	Width	----
	Type of Control	
X	Uncontrolled	----
	Controlled:	
----	Type (Flashboards; gate)	----
----	Number	----
----	Size/Length	----
	Invert Material	----
	Anticipated Length of Operating Service	----
----	Chute Length	----
----	Height Between Spillway Crest & Approach Channel Invert (Weir Flow)	----

HYDROMETEROLOGICAL GAGES:

Type: None

Location:

Records:

Date:

Max. Reading:

FLOOD WATER CONTROL SYSTEM:

Warning System: None

Method of Controlled Releases (mechanisms):

Outlet conduit with a gate valve

DRAINAGE AREA: 36.36 sq. mi.

DRAINAGE BASIN RUNOFF CHARACTERISTICS:

Land Use - Type: Urban

Terrain - Relief: Steep to mild

Surface - Soil: Well drained

Runoff Potential (existing or planned extensive alterations to existing surface or subsurface conditions)

No plans for changes in the basin

Potential Sedimentation problem areas (natural or man-made; present or future)

No problems reported

Potential Backwater problem areas for levels at maximum storage capacity including surcharge storage:

No problems observed

Dikes - Floodwalls (overflow & non-overflow) - Low reaches along the Reservoir perimeter:

Location: None

Elevation:

Reservoir:

Length @ Maximum Pool 3000 ft.

Length of Shoreline (@ Spillway Crest) 6200 ft.

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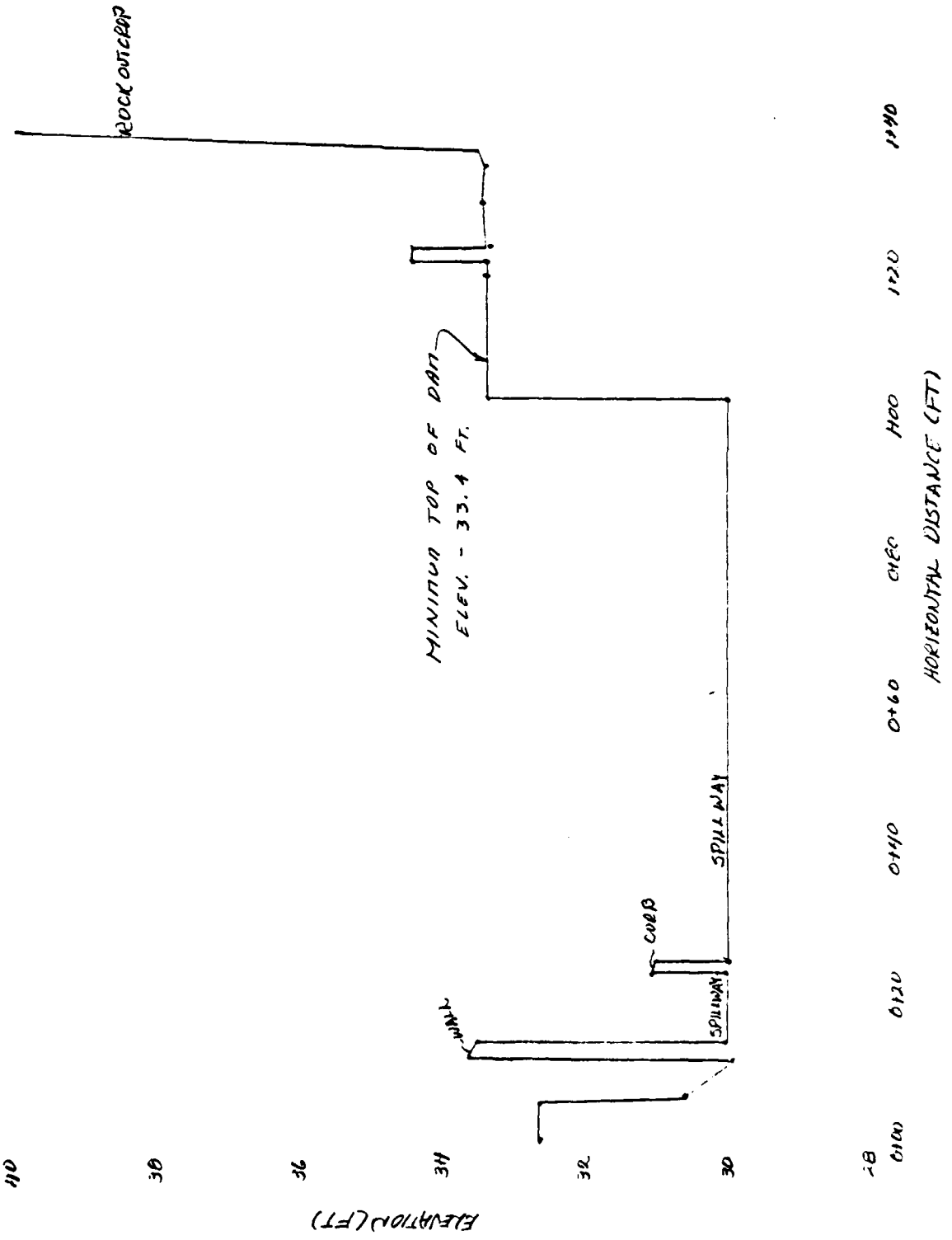
Beaver, Pa. 15009

Subject BRONX RIVER DAM — S.O. No.
TOP OF DAM PROFILE — Sheet No. 5 of 25
Drawing No.
Computed by SMZ — Checked by — Date 3/13/81



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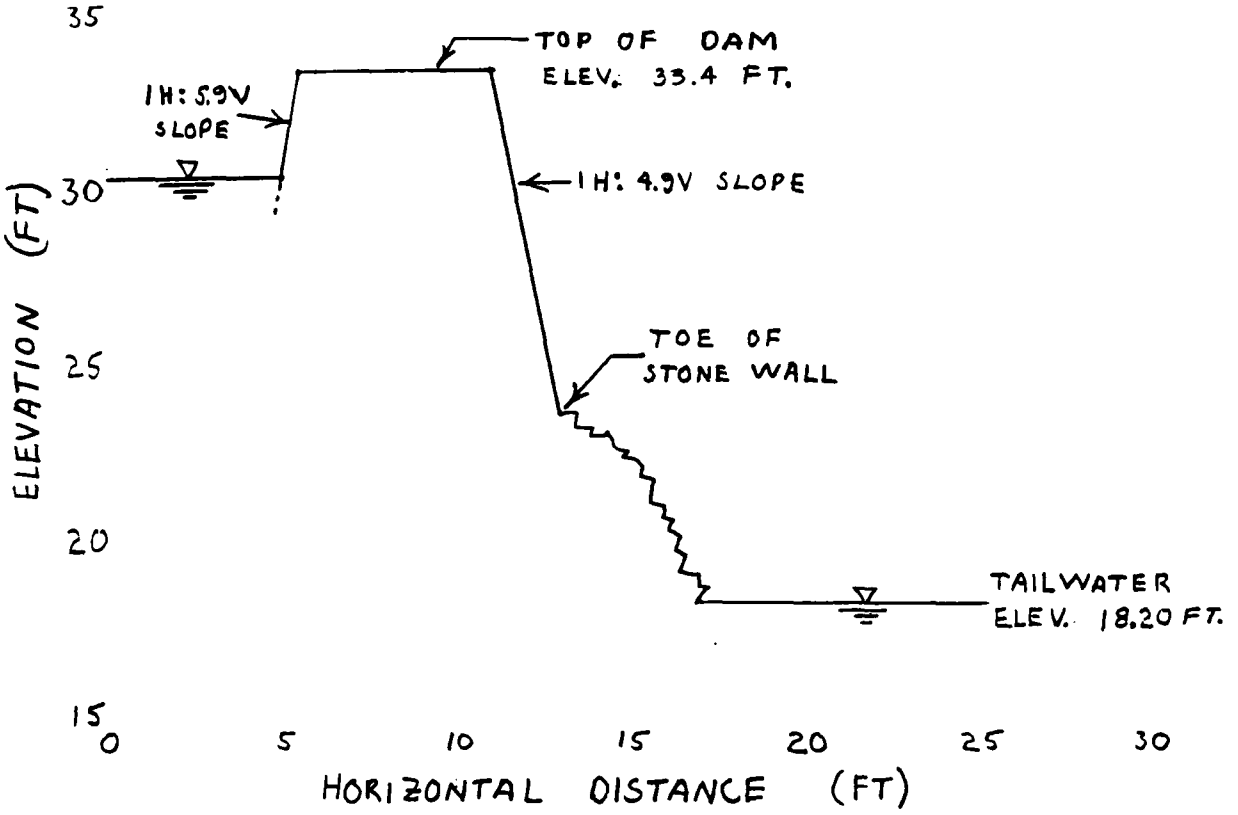
Beaver, Pa. 15009

Subject BRONX RIVER DAM S.O. No.
CROSS SECTION AT STA 1+15 Sheet No. 6 of 25
Drawing No.
Computed by APK Checked by [illegible] Date 3-22-81

CROSS SECTION OF DAM AT STATION 1+15



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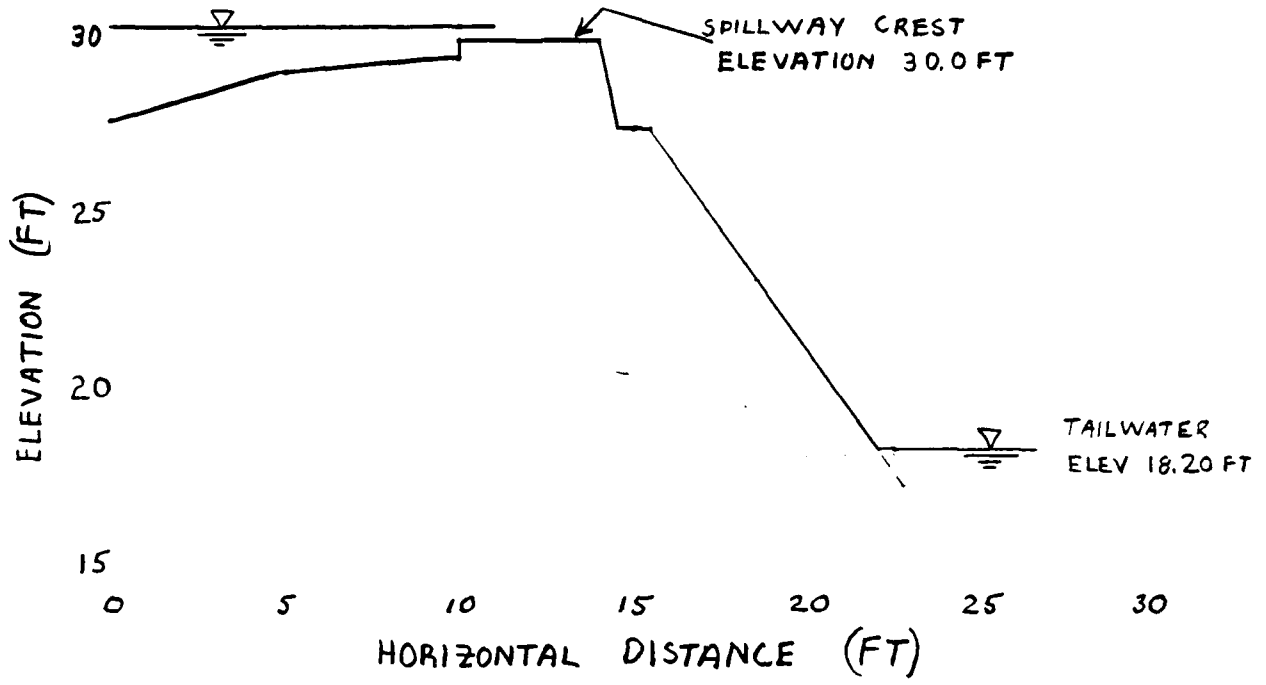
Subject BRONX RIVER DAM S.O. No.
SPILLWAY CROSS SECTION Sheet No. 7 of 25
Drawing No.
Computed by APK Checked by JE Date 3-22-81

SPILLWAY CROSS SECTION



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Subject BRONX RIVER DAM S.O. No.
SPILLWAY RATING Sheet No. 8 of 25
Drawing No.
Computed by APK Checked by Date 3-22-81

Weir Flow

$Q = C L H^{3/2}$

$Q = C\ 89.5\ H^{3/2}$

/ L = 89.5 FT

/ H varies from 0 to 12 feet and is measured from the crest of the spillway (elevation 30.0 ft M.S.L.)

C varies with H, King and Brater Handbook pg 5-40 Table 5-3

ELEVATION	C /	H (FT) /	Q (cfs)
30.0	—	0	0
30.3	2.5	0.3	368
31.0	2.7	1.0	242
32.0	2.7	2.0	683
33.0	2.7	3.0	1256
33.4	2.8	3.4	1571
34.0	2.8	4.0	2005
36.0	3.3	6.0	4341
38.0	3.3	8.0	6683
40.0	3.3	10.0	9340
42.0	3.3	12.0	12277
44.0	3.3	14.0	15471
46.0	3.3	16.0	18902

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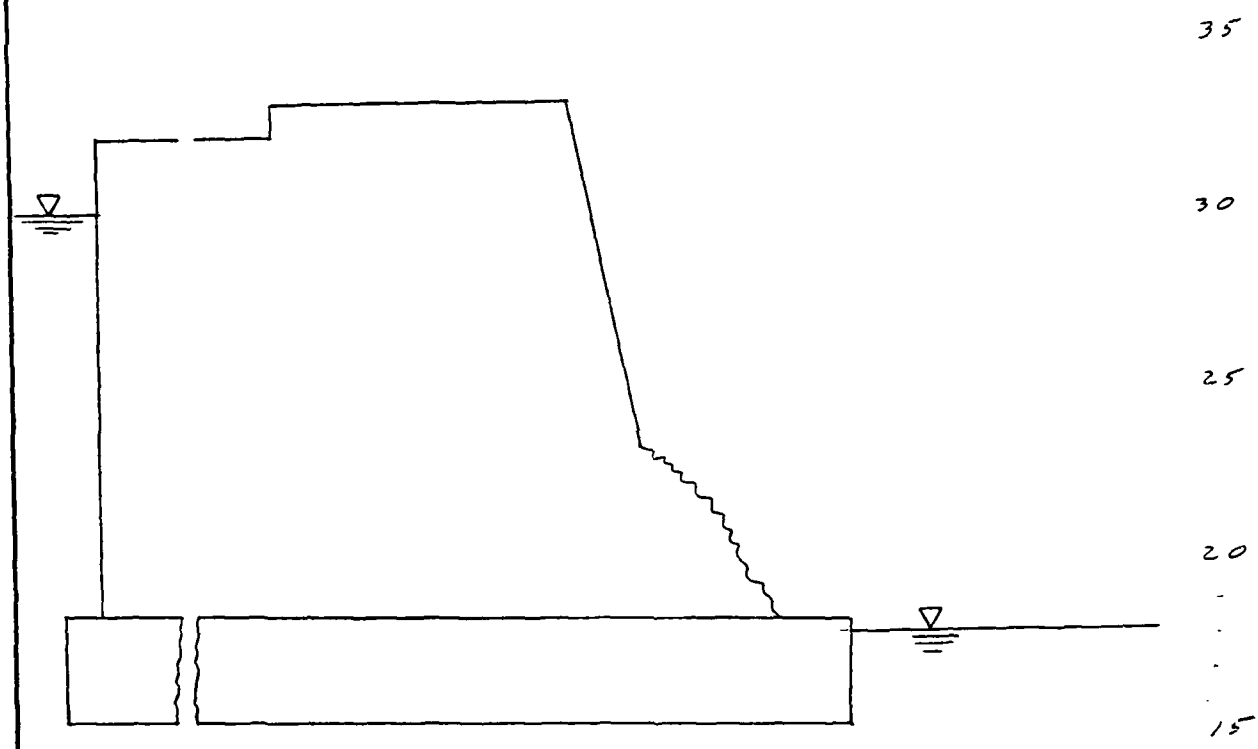
Subject BRONX RIVER DAM S.O. No.
OUTLET PIPE RATING Sheet No. 9 of 25
Drawing No.
Computed by GWT Checked by LAD Date 4/29/81

TYPICAL SECTION THRU OUTLET PIPE



INLET ELEV. - 16.0 FT. (ASSUMED) /
OUTLET ELEV. - 15.5 FT. /
PIPE DIAMETER - 3 FEET /
PIPE LENGTH - 30 FEET /
TAIL WATER - 18.2 FEET /

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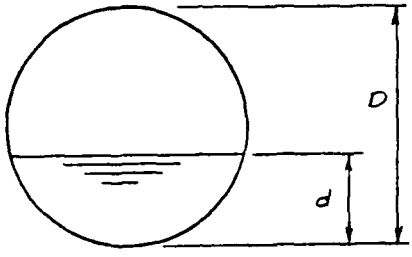
Subject BRONX RIVER DAM — S.O. No.
OUTLET PIPE RATING — Sheet No. 10 of 25
Drawing No.
Computed by GWT — Checked by LAD — Date 4/30/81

"DESIGN OF SMALL DAMS" PAGES 558 AND 559



D = DIA. PIPE
d = DEPTH OF WATER
S = PIPE SLOPE
$= \frac{16.-15.5}{30} = 0.017$

$n = 0.014$

ELEVATION = 18.0

$\frac{d}{D} = \frac{1}{2} = .5$ TABLE B-2 $1.3955 = \frac{Q_c}{D^{5/2}} = \frac{Q}{3^{5/2}}$ $Q = 21.75$ CFS

$\frac{d}{D} = \frac{1}{2} = .5$ TABLE B-3 $.232 = \frac{Q\,n}{D^{8/3}\,S^{1/2}} = \frac{Q\,(.014)}{3^{8/3}\,(0.017)^{1/2}}$ $Q = 40.45$ CFS.

ELEVATION = 18.75

$\frac{d}{D} = \frac{2.25}{3} = .75$ TABLE B-2 $3.0607 = \frac{Q_c}{D^{5/2}} = \frac{Q}{3^{5/2}}$ $Q = 47.71$

$\frac{d}{D} = \frac{2.25}{3} = .75$ TABLE B-3 $.422 = \frac{Q\,n}{D^{8/3}\,S^{1/2}} = \frac{Q\,(.014)}{3^{8/3}\,(.017)^{1/2}}$ $Q = 73.57$

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Subject BRONX RIVER DAM S.O. No.
OUTLET PIPE RATING Sheet No. 11 of 25
Drawing No.
Computed by GWT Checked by LAD Date 4/30/81

ORIFICE FLOW

$Q = CA(2gH)^{.5}$

$Q = 34.04(H)^{.5}$ ✓

$A = \pi R^2 = \pi(1.5)^2 = 7.07\ FT^2$ ✓

$g = 32.2\ FT/SEC^2$ ✓

H VARIES FROM 2 FT TO 12 FT ✓

C = 0.6 FROM TABLE 4-6 PG. 4-32
KING + BRATER d = 3 FT L = 30 FT. ✓

HEAD MEASURED TO CENTER OF PIPE

ELEVATION (FT)	H (FT)	Q (CFS)
20.0	3.0	59.0 ✓
21.0	4.0	68.1 ✓
22.0	5.0	76.1 ✓
23.0	6.0	83.4 ✓
24.0	7.0	90.1 ✓
25.0	8.0	96.3 ✓
26.0	9.0	102.1 ✓
27.0	10.0	107.6 ✓
28.0	11.0	112.9 ✓
29.0	12.0	117.9 ✓
30.0	13.0	122.7 ✓

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Subject BRONX RIVER DAM S.O. No.
OUTLET PIPE RATING Sheet No. 12 of 25
Drawing No.
Computed by GWT Checked by LAD Date 4/30/81

PIPE FLOW

$$Q = \frac{A(2gH)^{1/2}}{[1 + K_e + K_b + K_c(L)]^{1/2}}$$

$$= \frac{7.07(64.4H)^{1/2}}{[1 + .78 \cdot 0 + .00839(30)]^{1/2}}$$

$$= 39.80\ H^{1/2}$$

ELEVATION (FT)	H (Ft)	Q (CFS)
20.0	1.5	48.8
21.0	2.5	62.9
22.0	3.5	74.5
23.0	4.5	84.4
24.0	5.5	93.4
25.0	6.5	101.5
26.0	7.5	109.0
27.0	8.5	116.1
28.0	9.5	122.7
29.0	10.5	129.0
30.0	11.5	135.0

$A = \pi R^2 = 7.07$
$g = 32.2$ FT/SEC^2
H VARIES AND IS MEASURED FROM THE TOP OF PIPE ELEV. AT THE OUTLET.
$L = 30$ FT.
K_e (K_o) = .78 PG 5.5-6 SCS NEH-5
K_b (K_s) = 0 PG 5.5-10 SCS NEH-5
K_c (K_p) = .00839 PG 5.5-4 SCS NEH-5
$n = 0.014$
TOP OF 36" DIA. PIPE AT OUTLET = ELEV. 18.5 Ft.

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Subject BRONX RIVER DAM S.O. No.
OUTLET PIPE RATING SUMMARY Sheet No. 13 of 25
Drawing No.
Computed by GWT Checked by LAD Date 4/30/81

OUTLET PIPE SUMMARY RATING

ELEVATION (FT)	Q (CFS)
15.5	0
17.0	21.8
17.75	47.7
20.0	48.8
21.0	62.9
22.0	74.5
23.0	83.4
24.0	90.1
25.0	96.3
26.0	102.1
27.0	107.6
28.0	112.9
29.0	117.9
30.0	122.7

WEIGHTED C_p VALUE FOR DRAINAGE AREA
WEIGHTED RAINFALL VALUE FOR SPS

SUBAREA	AREA	C_p	T_p	RAINFALL
1	4.97	.39	5.1	12.73
2	6.45	.50	3.6	13.20
3	4.76	.63	2.4	14.28
4	2.79	.63	2.1	14.83
5	1.10	.50	4.0	14.83
6	1.89	.56	2.8	14.83
7	4.56	.66	10.0	14.83
8	3.04	.63	2.4	14.83
9	3.30	.63	2.2	14.67
10	3.50	.63	2.0	13.20

D.A = 36.36 SQ. MI.

$\frac{20.73}{36.36}$ = .57 C_p WEIGHTED

$\frac{509.42}{36.36}$ = 14.01 IN. RAINFALL WEIGHTED

SPS Q AT NODE 108 = 12,845 CFS
(FROM "LOWER HUDSON RIVER BASIN HYDROLOGIC FLOOD ROUTING MODEL" PAGES 152 - 157.)

HYDROGRAPH DEVELOPED AT NODE 108 USING t_p = 10.0 HR AND C_p = 0.57 WITH A RAINFALL OF 14.01 IN. PRODUCED A FLOW OF 13,060 C.F.S. THE PMP RAINFALL AMOUNT WAS THEN SUBSTITUTED TO GET THE PMF FLOWS.

RAINFALL DATA

From HMR-33

DAM AND DRAINAGE AREA ARE IN ZONE 1
PMP (24 HR) 200 MI^2 = 21.0 IN.
DRAINAGE AREA = 36.36 SQ. MI.
PMP (6 HR) - 96 % PMP (24 HR) 200 MI^2
PMP (12 HR) - 110 % " " "
PMP (24 HR) - 120 % " " "
PMP (48 HR) - 128 % " " "

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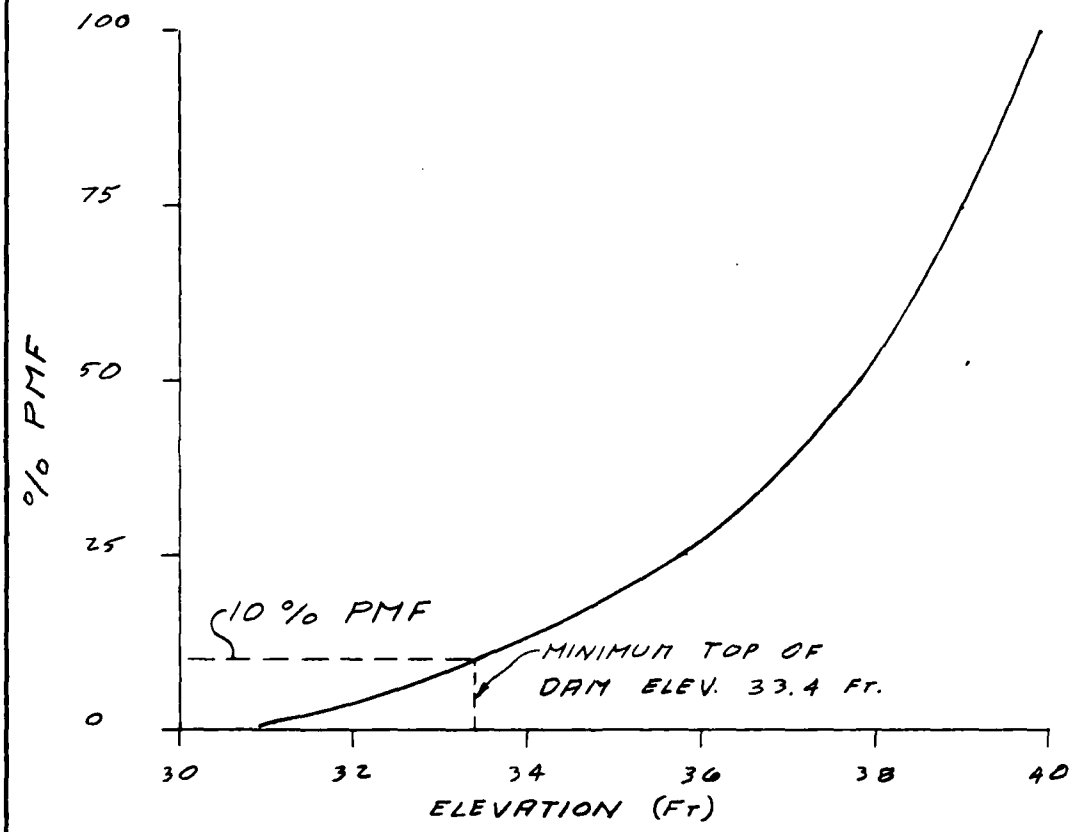
Beaver, Pa. 15009

Subject BRONX RIVER DAM S.O. No.
SPILLWAY CAPACITY ANALYSIS Sheet No. 15 of 25
Drawing No.
Computed by GWT Checked by LAD Date 4/30/81



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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
  MBJ JPOSTL         04 JUN 79
**********
    1              A1       NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
    2              A2       HYDROLOGIC AND HYDRAULIC ANALYSIS OF BRUNX RIVER DAM
    3              A3       UNIT HYDROGRAPH BY SNYDERS METHOD
    4              B     300        2        C        C        0        0        0        C       -6        0
    5              B1      5
    6              J       1        5        1
    7              J1    1.0     0.75     0.50     0.25     0.01
    8              K       0        1                                                 -1
    9              K1       RUNOFF HYDROGRAPH TO DAM
   10              M       1        1    36.36
   11              P                21.0       96      110      120      128
   12              I                                                    2.0      0.3
   13              L     10.0      .57
   14              X     -1.5    -0.05      2.0
   15              K       1        2                                          -1
   16              K1       ROUTING FOR BRUNX RIVER DAM
   17              Y                                 1        1
   18              Y1      1                                                -30.0       -1
   19              Y4    30.0     30.3     31.0     32.0     33.0     33.4     34.0     36.0     38.0     40.0
   20              Y4    42.0     44.0     46.0
   21              Y5       0     36.8      242      683     1256     1571     2005     4341     6083     9340
   22              Y5   12277    15471    18502
   23              $A       0      0.1      6.2     12.48    27.85    59.54
   24              $E      16       20       25       30       40       50
   25              $$    30.0
   26              $D    33.4      2.8      1.5
   27              $L       0      134      150      450      750      920     1090     1260
   28              $V    33.4       34       36       38       40       42       44       46
   29              K       99
```

SHEET 6 OF 25

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
 LAST MODIFICATION  26 FEB 79
  483 UPDATE          04 JUN 79
**********************************

RUN  DATE 05/20/81
     TIME    14.12

            NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
            HYDROLOGIC AND HYDRAULIC ANALYSIS OF BRONX RIVER DAM
            UNIT HYDROGRAPH BY SNYDERS METHOD

                               JOB SPECIFICATION
     NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
    300        2        0        0        0        0        0        0       -4        0
                             JOPER      NWT    LROPT    TRACE
                                 5        0        0        0        0

                        MULTI-PLAN ANALYSES TO BE PERFORMED
                          NPLAN= 1 NRTIO= 5 LRTIO= 1
   RTIOS=   1.00   0.75   0.50   0.25   0.01

**********        **********        **********        **********        **********

                         SUB-AREA RUNOFF COMPUTATION

          RUNOFF HYDROGRAPH TO DAM

              ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                  1       0       0       0       0       0      -1       0       0

                              HYDROGRAPH DATA
     IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
         1      1   30.36     0.0   30.36     0.0     0.0       0       0       0

                                PRECIP DATA
                 SPFE     PMS      R6     R12     R24     R48     R72     R96
                  0.0   21.00   96.00  110.00  120.00  128.00     0.0     0.0
TRSPC COMPUTED BY THE PROGRAM IS 0.841

                                 LOSS DATA
   LROPT  STRKR  DLTKR   RTIOL  ERAIN  STRKS  RTIOK  STRTL  CNSTL  ALSMX  RTIMP
       0    0.0    0.0    1.00    0.0    0.0   1.00   2.00   0.20    0.0    0.0

                           UNIT HYDROGRAPH DATA
                        TP= 10.00    CP=0.57    NTA=  0

                              RECESSION DATA
                   STRTQ=   -1.50   QRCSN=   -0.05   RTIOR= 2.00

    UNIT HYDROGRAPH 31 END-OF-PERIOD ORDINATES, LAG=   9.94 HOURS, CP= 0.58  VOL= 1.00
  109.      396.      700.     1137.     1351.     1348.     1170.      963.      792.      652.
  536.      441.      363.      299.      246.      202.      167.      137.      113.       93.
   76.       63.       52.       43.       35.       29.       24.       20.       16.       13.
   11.
```

SHEET 17 OF 25

END-OF-PERIOD FLOW

	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q		HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
							SUM	22.00	15.82	6.18	195820.		
								574.21	402.11	172.11	5549.24		

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING FOR BRONX RIVER DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	3	0	0	-1	0	0

ROUTING DATA

CLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	-30.	-1

STAGE	30.00	30.30	31.00	32.00	33.00	33.40	34.00	36.00	38.00	40.00
	42.00	44.00	46.00							
FLOW	0.0	36.80	242.00	683.00	1256.00	1571.00	2035.00	4341.00	6603.00	9340.00
	12277.00	15471.00	18902.00							
SURFACE AREA=	0.	0.	6.	12.	28.	60.				
CAPACITY=	0.	0.	12.	58.	255.	682.				
ELEVATION=	16.	20.	25.	30.	40.	50.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
33.4	2.8	1.5	0.

CREST LENGTH	0.	134.	150.	450.	750.	920.	1090.	1260.
AT OR BELOW ELEVATION	33.4	34.0	36.0	38.0	40.0	42.0	44.0	46.0

PEAK OUTFLOW IS 20405. AT TIME 48.00 HOURS

PEAK OUTFLOW IS 15328. AT TIME 50.00 HOURS

PEAK OUTFLOW IS 10207. AT TIME 48.00 HOURS

PEAK OUTFLOW IS 5118. AT TIME 48.00 HOURS

PEAK OUTFLOW IS 205. AT TIME 50.00 HOURS

********** ********** ********** ********** **********

SHEET 18 OF 27

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIO 2 0.75	RATIO 3 0.50	RATIO 4 0.25	RATIO 5 0.01
HYDROGRAPH AT	1	36.36	1	26952.	15369.	10246.	5123.	205.
	(	94.17)	(	580.28)(	435.21)(	290.14)(	145.07)(	5.80)(
ROUTED TO	2	36.36	1	20465.	15328.	10207.	5116.	205.
	(	94.17)	(	577.80)(	434.04)(	289.03)(	144.90)(	5.81)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	30.00	30.00	33.40
STORAGE	58.	58.	108.
OUTFLOW	0.	0.	1571.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	39.72	6.32	247.	20433.	48.00	90.00	0.0
0.75	38.82	5.42	223.	15326.	36.00	54.00	0.0
0.50	37.61	4.21	193.	10207.	33.00	48.00	0.0
0.25	35.66	2.26	150.	5114.	22.00	48.00	0.0
0.01	30.87	0.0	69.	203.	0.0	30.00	0.0

SHEET 20 OF 25

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
  MOD OPTION:        04 JUN 79
**********
     1              A1       NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
     2              A2       HYDROLOGIC AND HYDRAULIC ANALYSIS OF BRONX RIVER DAM
     3              A3       DEWATERING ANALYSIS OF BRONX RIVER DAM
     4              B    100       0       5       0       3       0       0       0       0       0
     5              B1     5
     6              J      1       1       1
     7              J1     1
     8              K      0       1                                       -1
     9              K1       NULL RUNOFF HYDROGRAPH TO DAM
    10              M     -1              36.36           36.36
    11              N
    12              N
    13              N
    14              N
    15              N
    16              N
    17              N
    18              N
    19              N
    20              N
    21              K      1       2                                       -1
    22              K1       DEWATERING BRONX RIVER DAM
    23              Y                                       1       1
    24              Y1     1                                               -30.0      -1
    25              Y4  15.5      17    17.75      20      21      22      23      24      25      26
    26              Y4     27      28      29      30
    27              Y5      0    21.8    47.7    48.8    62.9    74.5    83.4    90.1    96.3   102.1
    28              Y5  107.6   112.9   117.9   122.7
    29              $A      0     0.1     6.29   12.49   27.85   39.39
    30              $E     15      20      25      30      40      50
    31              $$   30.0
    32              $D   33.4     2.8     1.5
    33              K      99
```

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
  MDJ UPDATE         04 JUN 79
**********************************

RUN  DATE 03/23/31
     TIME    14.09


          NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
          HYDROLOGIC AND HYDRAULIC ANALYSIS OF BRONX RIVER DAM
          DEWATERING ANALYSIS OF BRONX RIVER DAM

                          JOB SPECIFICATION
   NQ    NHR   NMIN   IDAY    IHR   IMIN  METRC   IPLT   IPRT  NSTAN
  100      0      5      0      0      0      0      0      0      0
                      JOPER    NWT  LROPT  TRACE
                          5      0      0      0      0

                  MULTI-PLAN ANALYSES TO BE PERFORMED
                     NPLAN= 1 NRTIO= 1 LRTIO= 1
  RTIOS=   1.00


  **********     **********     **********     **********     **********

                    SUB-AREA RUNOFF COMPUTATION

         NULL RUNOFF HYDROGRAPH TO DAM

              ISTAQ  ICOMP  IECON  ITAPE  JPLT   JPRT  INAME ISTAGE  IAUTO
                  1      0      0      0      0      0     -1      0      0

                            HYDROGRAPH DATA
  IHYDG   IUHG  TAREA   SNAP  TRSDA  TRSPC  RATIO  ISNOW  ISAME  LOCAL
     -1      0  36.36    0.0  36.36    0.0  0.0        0      0      0

                            INPUT HYDROGRAPH
   0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
   0.        0.        0.        0.        0.        0.        0.        0.        0.        0.

                   PEAK   6-HOUR  24-HOUR  72-HOUR   TOTAL VOLUME
           CFS       0.       0.       0.       0.             0.
           CMS       0.       0.       0.       0.             0.
        INCHES               0.0      0.0      0.0            0.0
            MM               0.0      0.0      0.0            0.0
         AC-FT                0.       0.       0.             0.
      THOUS CU M              0.       0.       0.             0.
```

SHEET 22 OF 25

```
                              HYDROGRAPH AT STA     1 FOR PLAN 1, RTIO 1
      0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
      0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
      0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
      0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
      0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
      0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
      0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
      0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
      0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
      0.        0.        0.        0.        0.        0.        0.        0.        0.        0.

                                PEAK    6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
                      CFS         0.        0.        0.        0.          0.
                      CMS         0.        0.        0.        0.          0.
                   INCHES                 0.0       0.0       0.0         0.0
                       MM                 0.0       0.0       0.0         0.0
                    AC-FT                   0.        0.        0.          0.
               THOUS CU M                   0.        0.        0.          0.


      **********         **********         **********         **********         **********

                                          HYDROGRAPH ROUTING

             DEWATERING BRONX RIVER DAM

                      ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT   INAME   ISTAGE   IAUTO
                          2       1       0       0      0      0      -1        0       0
                                             ROUTING DATA
             QLOSS    CLOSS     AVG    IRES   ISAME   IOPT   IPMP            LSTR
               0.0      0.0     0.0       1       1      0      0               0

                     NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA   ISPRAT
                         1       0       0     0.0     0.0     0.0    -30.       -1

STAGE        15.50     17.00     17.75     20.00     21.00     22.00     23.00     24.00     25.00     26.00
             27.00     28.00     29.00     30.00

FLOW           0.0     21.80     47.70     46.80     62.90     74.50     83.40     90.10     90.30    102.10
            107.60    112.90    117.90    122.70

SURFACE AREA=       0.        0.        6.       12.       28.       60.

   CAPACITY=        0.        0.       12.       58.      255.      682.

  ELEVATION=       16.       20.       25.       30.       40.       50.

                       CREL    SPWID    COQW    EXPW    ELEVL    COQL    CAREA    EXPL
                       30.0      0.0     0.0     0.0      0.0     0.0      0.0     0.0

                                                DAM DATA
                                     TOPEL    COQD    EXPD   DAMWID
                                      33.4     2.8     1.5       0.

                                     STATION      2, PLAN 1, RATIO 1

                                     END-OF-PERIOD HYDROGRAPH ORDINATES
                    MO.DA   HR.MN   PERIOD   HOURS    INFLOW    OUTFLOW    STORAGE     STAGE

                     1.01    0.05        1    0.08        0.       12.        57.      25.9
```

SHEET 23 OF 25

1.01	0.10	2	0.17	0.	122.	98.	29.5
1.01	0.15	3	0.25	0.	122.	95.	29.6
1.01	0.20	4	0.33	0.	122.	93.	29.4
1.01	0.25	5	0.42	0.	122.	94.	29.4
1.01	0.30	6	0.50	0.	121.	93.	29.4
1.01	0.35	7	0.58	0.	120.	92.	29.5
1.01	0.40	8	0.67	0.	120.	91.	29.4
1.01	0.45	9	0.75	0.	120.	90.	29.4
1.01	0.50	10	0.83	0.	119.	90.	29.3
1.01	0.55	11	0.92	0.	119.	89.	29.2
1.01	1.00	12	1.00	0.	119.	88.	29.2
1.01	1.05	13	1.08	0.	118.	87.	29.1
1.01	1.10	14	1.17	0.	118.	86.	29.0
1.01	1.15	15	1.25	0.	118.	86.	28.9
1.01	1.20	16	1.33	0.	117.	85.	28.9
1.01	1.25	17	1.42	0.	117.	84.	28.8
1.01	1.30	18	1.50	0.	117.	83.	28.7
1.01	1.35	19	1.58	0.	116.	82.	28.6
1.01	1.40	20	1.67	0.	116.	82.	28.6
1.01	1.45	21	1.75	0.	115.	81.	28.5
1.01	1.50	22	1.83	0.	115.	80.	28.4
1.01	1.55	23	1.92	0.	115.	79.	28.3
1.01	2.00	24	2.00	0.	114.	80.	28.3
1.01	2.05	25	2.08	0.	114.	80.	28.2
1.01	2.10	26	2.17	0.	113.	79.	28.1
1.01	2.15	27	2.25	0.	113.	80.	28.0
1.01	2.20	28	2.33	0.	112.	80.	27.9
1.01	2.25	29	2.42	0.	112.	80.	27.9
1.01	2.30	30	2.50	0.	112.	79.	27.8
1.01	2.35	31	2.58	0.	111.	80.	27.7
1.01	2.40	32	2.67	0.	111.	82.	27.6
1.01	2.45	33	2.75	0.	110.	81.	27.5
1.01	2.50	34	2.83	0.	110.	81.	27.5
1.01	2.55	35	2.92	0.	110.	80.	27.4
1.01	3.00	36	3.00	0.	109.	79.	27.3
1.01	3.05	37	3.08	0.	109.	78.	27.2
1.01	3.10	38	3.17	0.	108.	78.	27.1
1.01	3.15	39	3.25	0.	108.	77.	27.0
1.01	3.20	40	3.33	0.	107.	76.	26.9
1.01	3.25	41	3.42	0.	107.	75.	26.9
1.01	3.30	42	3.50	0.	106.	75.	26.8
1.01	3.35	43	3.58	0.	106.	74.	26.7
1.01	3.40	44	3.67	0.	105.	73.	26.6
1.01	3.45	45	3.75	0.	105.	73.	26.5
1.01	3.50	46	3.83	0.	104.	72.	26.4
1.01	3.55	47	3.92	0.	104.	71.	26.3
1.01	4.00	48	4.00	0.	103.	70.	26.2
1.01	4.05	49	4.08	0.	103.	70.	26.1
1.01	4.10	50	4.17	0.	102.	69.	26.0
1.01	4.15	51	4.25	0.	102.	68.	25.9
1.01	4.20	52	4.33	0.	101.	68.	25.8
1.01	4.25	53	4.42	0.	101.	67.	25.7
1.01	4.30	54	4.50	0.	100.	66.	25.6
1.01	4.35	55	4.58	0.	99.	65.	25.5
1.01	4.40	56	4.67	0.	99.	65.	25.4
1.01	4.45	57	4.75	0.	98.	64.	25.3
1.01	4.50	58	4.83	0.	98.	63.	25.2
1.01	4.55	59	4.92	0.	97.	63.	25.1
1.01	5.00	60	5.00	0.	96.	62.	25.0
1.01	5.05	61	5.08	0.	96.	61.	24.9
1.01	5.10	62	5.17	0.	95.	61.	24.8
1.01	5.15	63	5.25	0.	94.	60.	24.7
1.01	5.20	64	5.33	0.	94.	60.	24.6
1.01	5.25	65	5.42	0.	93.	59.	24.4
1.01	5.30	66	5.50	0.	93.	59.	24.3

1.01	5.45	96	5.75	0.	87.	6.	23.9
1.01	5.50	76	5.83	0.	88.	6.	23.7
1.01	5.55	77	5.92	0.	87.	5.	23.6
1.01	6.00	78	6.00	0.	86.	5.	23.4
1.01	6.05	79	6.08	0.	85.	4.	23.2
1.01	6.10	80	6.17	0.	83.	3.	23.0
1.01	6.15	81	6.25	0.	81.	3.	22.8
1.01	6.20	82	6.33	0.	79.	2.	22.5
1.01	6.25	83	6.42	0.	76.	2.	22.2
1.01	6.30	84	6.50	0.	73.	1.	21.9
1.01	6.35	85	6.58	0.	68.	1.	21.4
1.01	6.40	86	6.67	0.	58.	0.	20.7
1.01	6.45	87	6.75	0.	24.	0.	17.1
1.01	6.50	88	6.83	0.	0.	0.	16.0
1.01	6.55	89	6.92	0.	0.	0.	16.0
1.01	7.00	90	7.00	0.	0.	0.	16.0
1.01	7.05	91	7.08	0.	0.	0.	16.0
1.01	7.10	92	7.17	0.	0.	0.	16.0
1.01	7.15	93	7.25	0.	0.	0.	16.0
1.01	7.20	94	7.33	0.	0.	0.	16.0
1.01	7.25	95	7.42	0.	0.	0.	16.0
1.01	7.30	96	7.50	0.	0.	0.	16.0
1.01	7.35	97	7.58	0.	0.	0.	16.0
1.01	7.40	98	7.67	0.	0.	0.	16.0
1.01	7.45	99	7.75	0.	0.	0.	16.0
1.01	7.50	94	7.83	0.	0.	0.	16.0
1.01	7.55	95	7.92	0.	0.	0.	16.0
1.01	8.00	96	8.00	0.	0.	0.	16.0
1.01	8.05	97	8.08	0.	0.	0.	16.0
1.01	8.10	98	8.17	0.	0.	0.	16.0
1.01	8.15	99	8.25	0.	0.	0.	16.0
1.01	8.20	100	8.33	0.	0.	0.	16.0

PEAK OUTFLOW IS 123. AT TIME 0.0 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	122.	107.	83.	83.	8311.
CMS	3.	3.	2.	2.	235.
INCHES		0.03	0.03	0.03	0.03
MM		0.70	0.75	0.75	0.75
AC-FT		53.	57.	57.	57.
THOUS CU M		66.	71.	71.	71.

********** ********** ********** ********** **********

APPENDIX D

REFERENCES

REFERENCES

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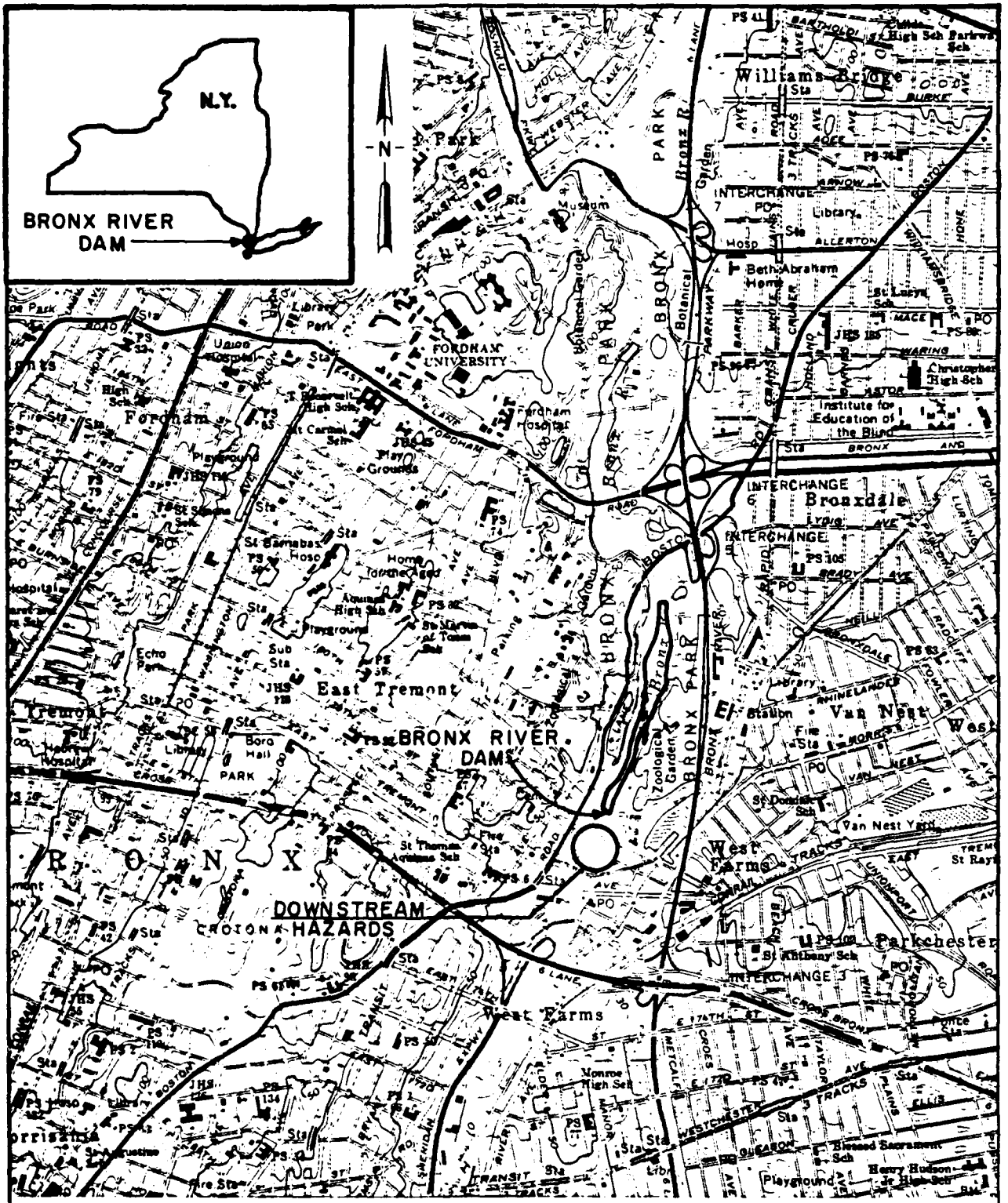
APPENDIX E

DRAWINGS

CONTENTS



SCALE 1:24000

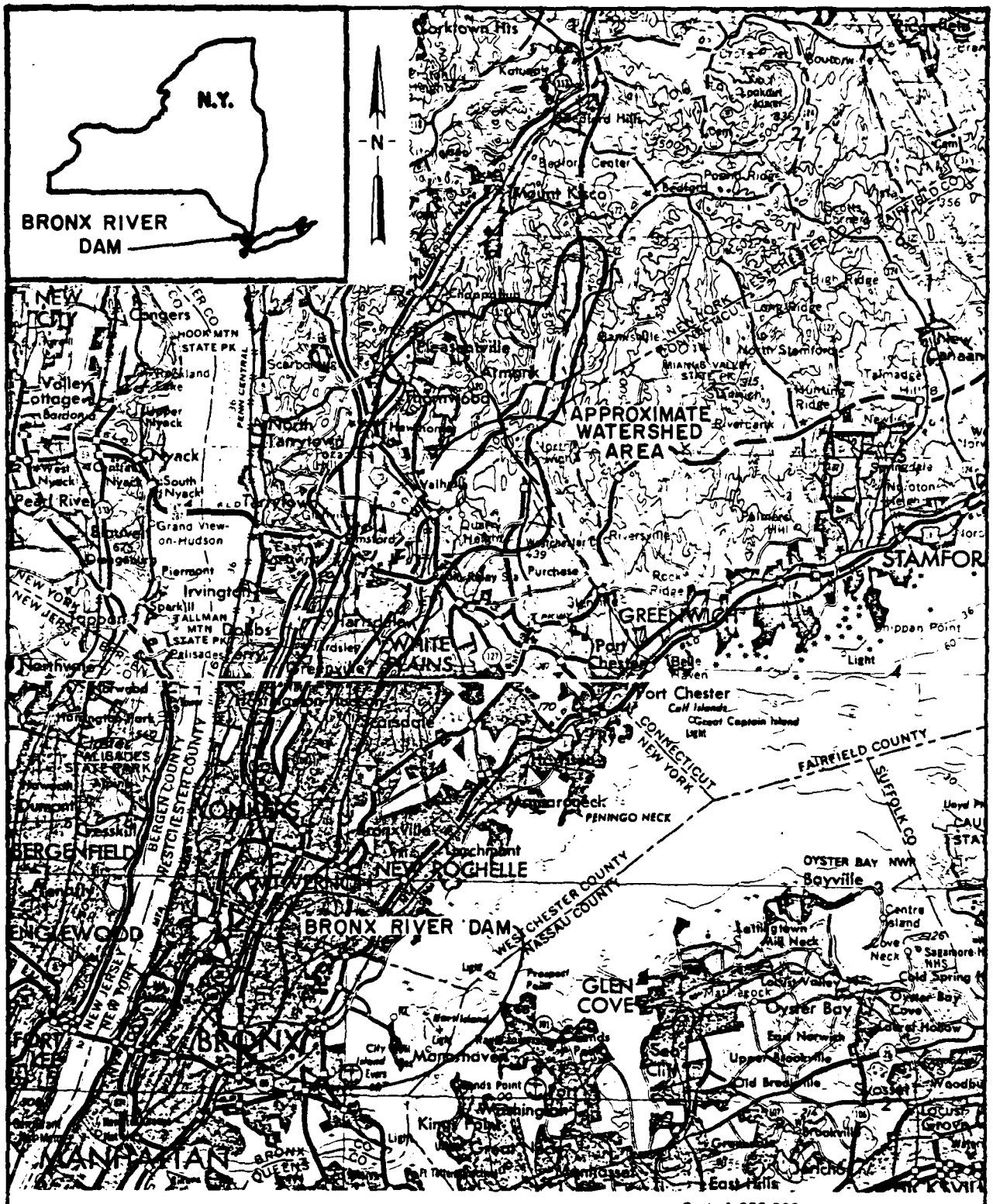
1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

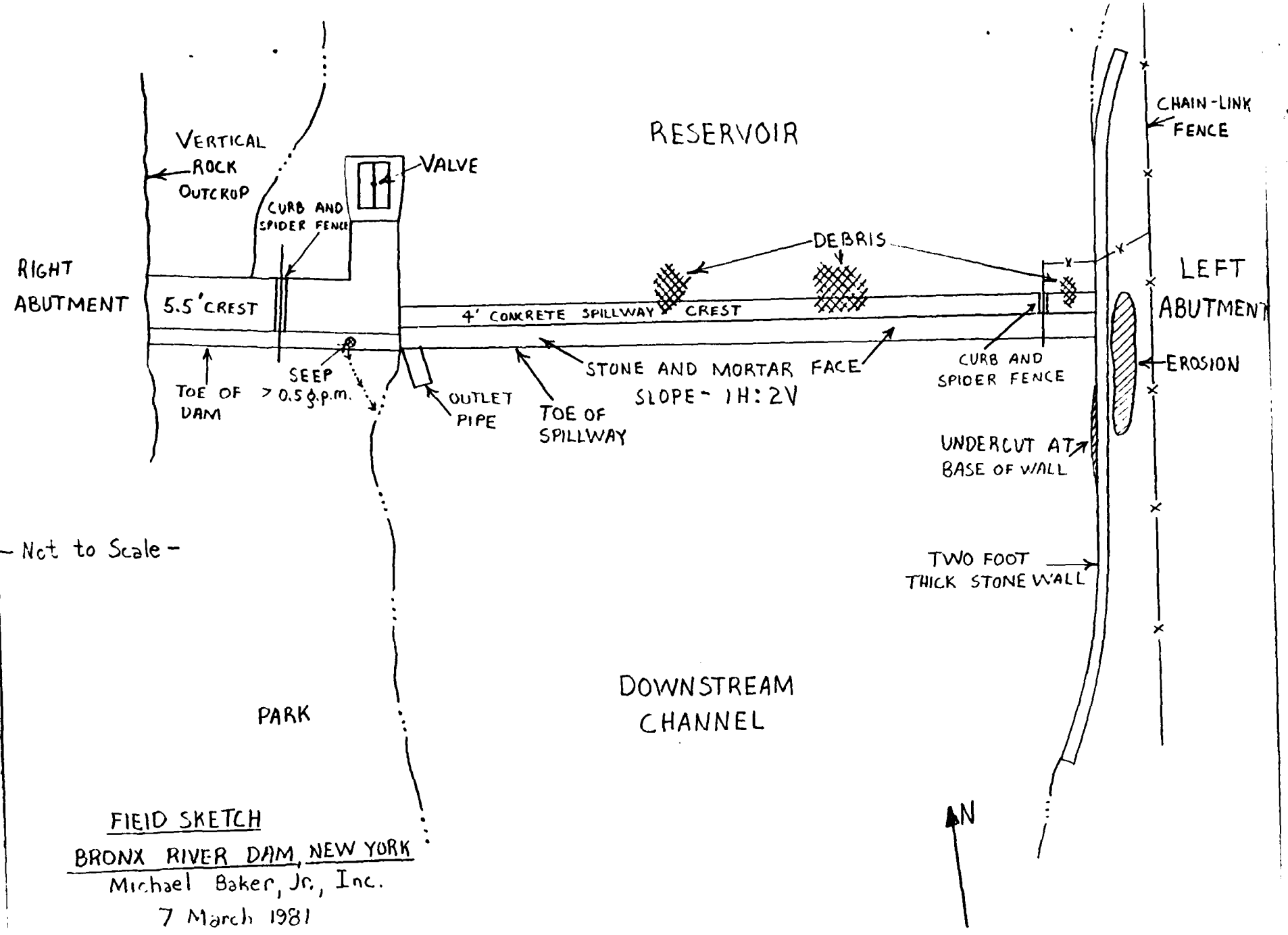
REFERENCES:
1. U.S.G.S. 7.5' CENTRAL PARK, N.Y.-N.J. QUADRANGLE. PHOTOREVISED 1979
2. U.S.G.S. 7.5' FLUSHING, N.Y. QUADRANGLE. PHOTOREVISED 1979

LOCATION PLAN
BRONX RIVER DAM



REFERENCES:
1. U.S.G.S. 1:250,000 HARTFORD, CONN., N.Y., N.J., MASS. QUADRANGLE. REVISED 1975
2. U.S.G.S. 1:250,000 NEW YORK N.Y., N.J., CONN. QUADRANGLE. REVISED 1979

WATERSHED MAP
BRONX RIVER DAM



FIELD SKETCH

BRONX RIVER DAM, NEW YORK

Michael Baker, Jr., Inc.

7 March 1981

PLATE 1

APK 3-81

APPENDIX F

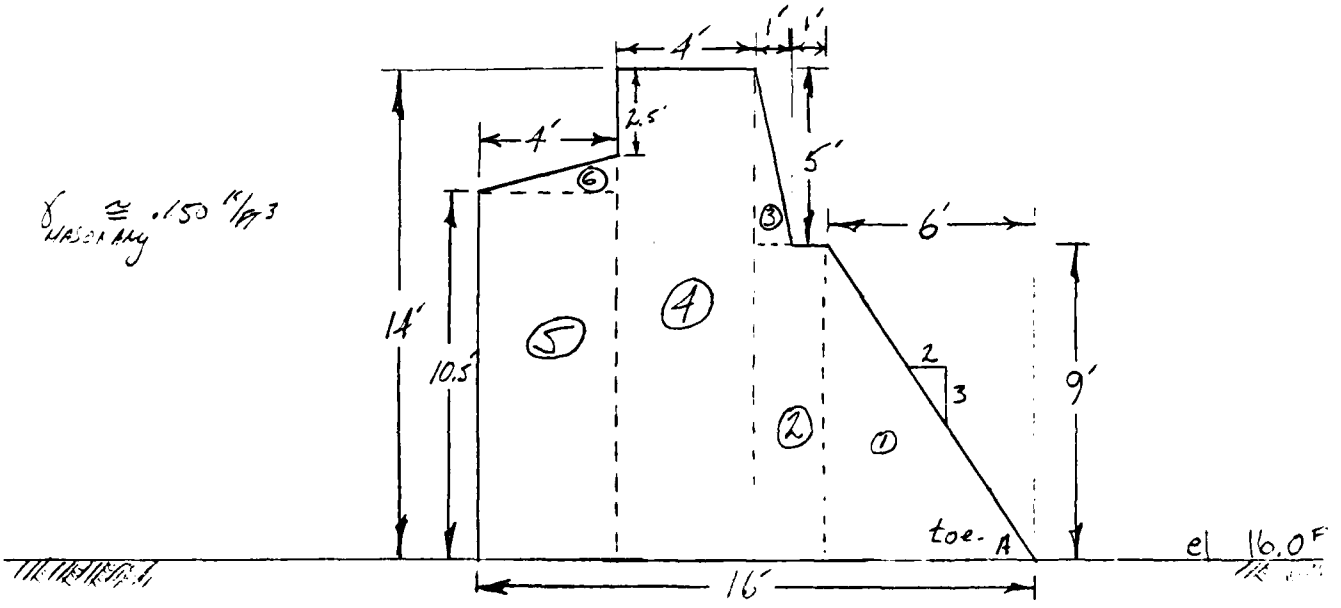
STABILITY CALCULATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject: Bronx River Dam — Stability Analysis — Spillway Section
S.O. No. K-223-00-ALP
Sheet No. 1 of 11
Drawing No.
Computed by DWM Checked by JGU Date MAY 8, 1991

Spillway Cross-Section (Overflow Section) — Masonary Rock Dam



Section			γ	W	Distance From toe	M
①	½(6)(9) =	27	.15 K/FT³	4.05 KIPS	4.0	16.2 K-FT
②	2(9) =	18	.15	2.7	7.0	18.9
③	½(1)(5) =	2.5	.15	0.375	7.667	2.875
④	4(14) =	56	.15	8.4	10.0	84
⑤	4(10.5) =	42	.15	6.3	14.0	88.2
⑥	½(1)(4) =	2	.15	0.3	13.333	4.0
				22.125		214.175

Resultant = 22.125 KIPS

Distance From toe = $\frac{214.175}{22.125}$ = 9.68 FT From toe

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject: Brown River Dam — Stability Analysis
S.O. No. 15333-05-AAD
Sheet No. 2 of 11
Drawing No.
Computed by DWK Checked by JGU Date May 3, 1981

Situations to be Considered

Case I Normal Operating Conditions, full uplift

Case II Same as Case I plus Ice loading

Case III Conditions due 1/2 PMF, full Uplift

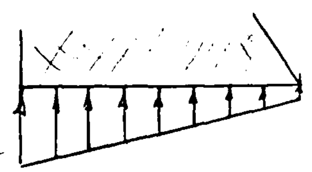
Case IV Conditions due Full PMF, full Uplift

Case I Pool level = el 30.0' $H_w = 14^{FT}$

Tail water level = el. 13.0' $H_w = 2.2^{FT}$

Uplift Reservoir Side = 14(.0625) = 0.875 KSF

Tailwater Side = (2.2)(.0625) = 0.138 KSF



$$\text{Resultant} = \left(\frac{.875 + .138}{2}\right)(16) = 8.104 \text{ Kips}$$

$$\text{Location} = \frac{[.138(16)]\,16/2 + [(.875 - .138)(1/2)(16)]\,16/3}{8.104}$$

$= 6.060^{FT}$

$\Rightarrow$ 16 − 6.06 = 9.94 FT from toe

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject: Bronx River Dam — Stability Analysis   S.O. No. 13333-…-AKA
Sheet No. 3 of 11
Drawing No.
Computed by DJM   Checked by JGU   Date May 8, 1981

Hydro Static Pressure

Reservoir Side = $(14)^2(.0625)\frac{1}{2} = 6.125$ Kips

location = $14/3 = 4.667$ FT from base level (el 16.0)

Tailwater Side = $(2.2)^2(.0625)\frac{1}{2} = .151$ Kips

location = $2.2/3 = 0.733$ FT from base level

Addition Vertical load Due to Tailwater

$W = 2.2[(2/3)(2.2)](1/2)(.0625) = 0.101$ Kips

location $[(2/3)(2.2)]1/3 = 0.489$ FT from toe

UPSTREAM

$4(2.5)(.0625) = .625^k$ 14′

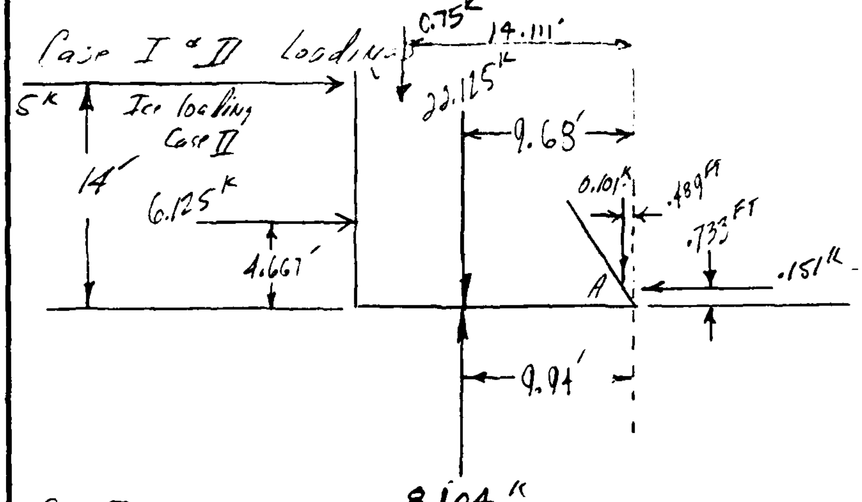
$1(4)(1/2)(.0625) = .125^k$ 14.66′

0.75^k

Location $\frac{(.625)(14)+(.125)(14.66)}{.75}$

$= 14.111$ ft from toe

Case I & II Loading



Case I

Overturning

$F.S._{overturning} = \frac{(0.75)(14.111) + 9.68(22.125) + 0.101(.489) + .733(.151)}{8.104(9.94) + 4.667(6.125)}$

F.S. overturning = 2.96

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Beaver River Dam — S.O. No. 13333-003-ACA
Stability Analysis — Sheet No. 4 of 11
Drawing No.
Computed by DWH — Checked by JGH — Date May 3, 1991

Sliding

$S = 2$ KSF
$\phi = 35°$

$R = \Sigma V \tan\phi + SA$
$= (23.125 + 0.101 + 0.75 - 8.104)0.7 + 2(16)$
$= 42.41$ kips

$H = 6.125 - .151$
$= 5.974$ k

$F.S._{sliding} = \frac{42.41}{5.974}$

$F.S._{sliding} = 7.10$

Case II

Overturning

$$F.S._{overturning} = \frac{7.68(23.125) + .101(.787) + .253(.151) + .75(14.111)}{8.104(7.94) + 4.667(6.125) + 5(14)}$$

$F.S._{overturning} = 1.26$

Sliding

$R = 42.41$

$H = 6.125 + 5 - .151$
$= 10.974$

$F.S._{sliding} = \frac{42.41}{10.974}$

$F.S._{sliding} = 3.36$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Beaver River Dam — S.O. No. [illegible]-AAL
Stability Analysis — Sheet No. 5 of 11
Drawing No.
Computed by DWM — Checked by JGU — Date 11/13/1531

Case III

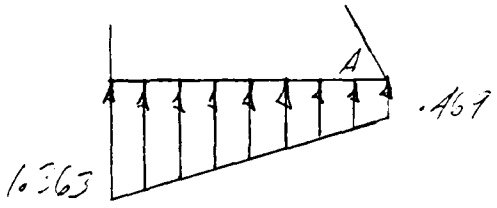
Reservoir level = el 578 $H_w = 21.8^{FT}$

Tailwater level = el 223.5 $H_w = 7.5^{FT}$

% lift

$21.3(.0625) = 1.363^{KSF}$ Reservoir Side

$7.5(.0625) = .469^{KSF}$ Tailwater Side



$$\text{Resultant} = \left(\frac{.469+1.363}{2}\right)(16) = 14.656^{kips}$$

$$\text{location} = \frac{[.469(16)]\frac{16}{2} + [(1.363-.469)(\tfrac{1}{2})(16)]\tfrac{2}{3}(16)}{14.656}$$

$$= 9.301^{FT} \text{ from toe}$$

% lift Static Pressure

Factor Dam = 21.8 (.0625) = 1.363

Tail Dam = 7.8 (.0625) = .488

Resultant = $\frac{(1.363+.488)}{2}(14) = 12.957^{kips}$

location = $\frac{[.488(14)]\frac{14}{2} + [(1.363-.488)\tfrac{1}{2}(14)]\tfrac{14}{3}}{12.957}$

[illegible] case of Dam

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Kinzua River Dam S.O. No. [illegible]
Stability Analysis Sheet No. 6 of 11
Drawing No.
Computed by UUM Checked by JGU Date May 8, 1981

Hydrostatic Pressure

Tailwater Side

$$\text{Resultant} = \tfrac{1}{2}(7.5)^2(.0625)$$

$$= 1.758 \text{ kips}$$

$$\text{location} = 7.5/3 = 2.5 \text{ FT above base}$$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject: Raoux River Dam — Stability Analysis
S.O. No. 12973-13-A0A
Sheet No. 7 of 11
Drawing No.
Computed by DWM Checked by JGU Date May 8, 1981

Addition Verticle loading

location from toe

Reservoir Side $4(2.5)(.0625) = .625^K$ 14'

$(1)(4)(\frac{1}{2})(.0625) = .125^K$ 14.667'

$.750^K$

Resultant $= .750^K$

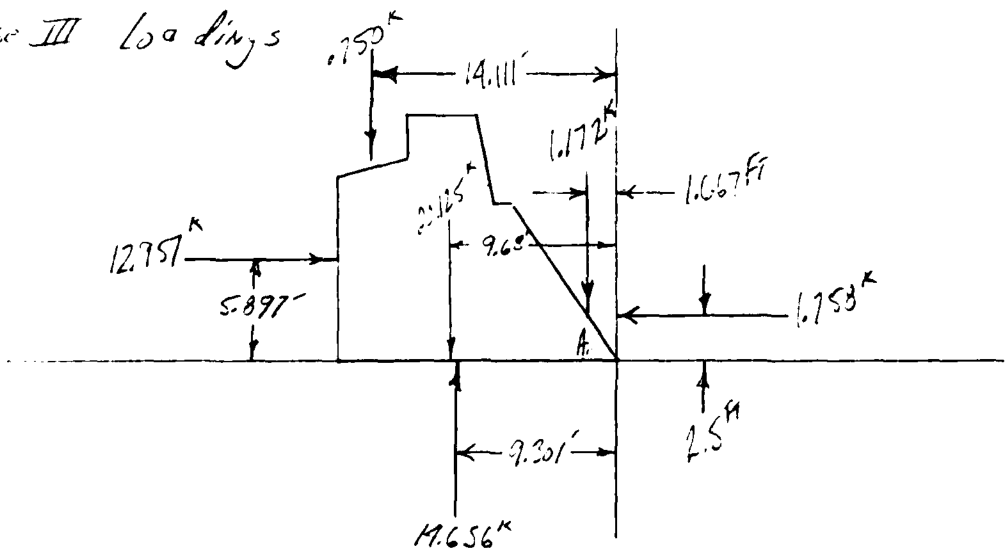
location $= \dfrac{.625(14) + .125(14.667)}{.750}$

$= 14.111^{FT}$ from toe

Tailwater Side $7.5[(2/3)(7.5)]\frac{1}{2}(.0625) = 1.172$ Kips

location $[(2/3)(7.5)]\frac{1}{3} = 1.667^{FT}$ from toe

Case III Loadings



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Low Flow Dam — S.O. No. 1390-3-AAF
Stability Analysis — Sheet No. 8 of 11
Drawing No.
Computed by DWM — Checked by JGU — Date May 8, 1981

Overturning:

$$F.S._{overturning} = \frac{22.125(9.68) + 1.172(1.667) + .750(14.111) + 1.755(2.5)}{12.957(5.899) + 14.656(9.301)}$$

$F.S._{overturning} = 1.086$

Sliding:

$$R = (22.125 + .750 + 1.172 - 14.656).7 + 2(16)$$
$$= 38.574^{K}$$

$$H = 12.957 - 1.758 = 11.199$$

$$F.S._{sliding} = R/H = \frac{38.574}{11.199}$$

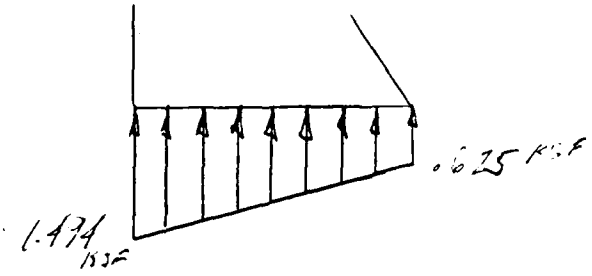
$F.S._{sliding} = 3.444$

Case IV

Pool level = el 39.9 FT — H_w = 23.9 FT
Tailwater level = 26.0 FT — H_w = 10.0 FT

Uplift

23.9 (.0625) = 1.494 KSF Reservoir Side
10 (.0625) = .625 KSF Tailwater Side



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THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Ernest River Dam — S.O. No. 12222-00-AR4
Stability Analysis — Sheet No. 9 of 11
Drawing No.
Computed by DWM — Checked by JGU — Date May 9, 1991

$$\text{Resultant} = \left(\frac{1.494 + .625}{2}\right)(16) = 16.952 \text{ kips}$$

$$\text{location} = \frac{\left[.625(16)\right]\frac{16}{2} + \left[(1.494-.625)(\tfrac{1}{2})(16)\right]\tfrac{2}{3}(16)}{16.952}$$

$$= 9.094 \text{ from toe of Dam}$$

Hydrostatic Pressure

Reservoir Side

Bottom of Dam = 23.9(.0625) = 1.494

Top of Dam = (23.1-4)(.0625 = .619

$$\text{Resultant} = \left(\frac{1.494 + .619}{2}\right)14 = 14.789^{k}$$

$$\text{Location} = \frac{\left[.619(14)\right]14/2 + \left[(1.494-.619)\tfrac{1}{2}(14)\right]14/3}{14.789}$$

$$= 6.035^{FT} \text{ above base of Dam}$$

Tailwater Side

$$\text{Resultant} = \tfrac{1}{2}(10)^2(.0625) = 3.125^{k}$$

$$\text{location} = 10/3 = 3.333^{FT} \text{ above base of Dam}$$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Bronx River Dam — Stability Analysis — S.O. No. 12088-00-ARR
Sheet No. 10 of 11
Drawing No.
Computed by DMM — Checked by JGH — Date May 8, 1991

Additional Vertical loading

		location from toe
Reservoir Side	$4(2.5)(.0625) = .625^k$	14'
	$(1)(4)(\frac{1}{2})(.0625) = .125^k$	14.667'
	$.750^k$	

Resultant $= .750^k$

$$\text{location} = \frac{.625(14) + .125(14.667)}{.750}$$

$= 14.111^{FT}$ from toe

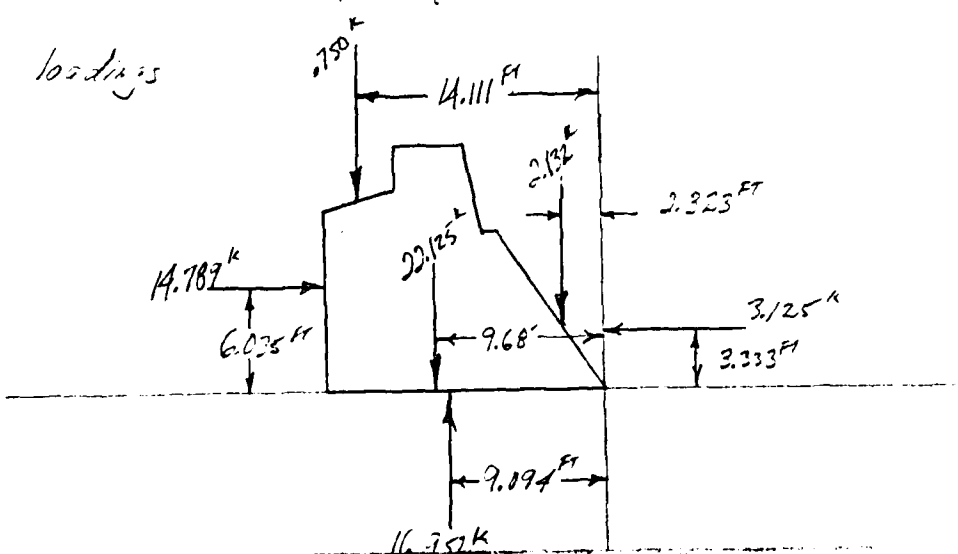
Tailwater Side		location from toe
$\frac{1}{2}(6)(9)(.0625)$	$= 1.688^k$	2'
$7(1)(.0625)$	$= 0.438$	3.5
$\frac{1}{2}(2)(1)(.0625)$	$= 0.006$	7.333
	2.132^k	

Resultant $= 2.132^k$

$$\text{location} = \frac{(1.688)2 + (.438)3.5 + .006(7.333)}{2.132}$$

$= 2.323^{FT}$ from toe

Case III loadings



MICHAEL BAKER, JR., INC.
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Box 280
Beaver, Pa. 15009

Subject [illegible] S.O. No. [illegible]
Sheet No. 11 of 11
Drawing No.
Computed by LVM Checked by JGU Date 11/1991

Overturning

$$F.S._{Overturning} = \frac{2.125(9.69) + 2.132(2.323) + 3.125(3.333) + .750(14.11)}{14.789(6.925) + 16.752(9.041)}$$

$$F.S._{Overturning} = 0.986$$

Sliding

$$R = (.750 + 22.125 + 2.132 - 16.752).7 + 2(1.5)$$

$$= 37.639^{k}$$

$$H = 14.789 - 3.125 = 11.664^{k}$$

$$F.S._{Sliding} = R/H = \frac{37.639}{11.664}$$

$$F.S._{Sliding} = 3.227$$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Brux River Dam — Stability Analysis

S.O. No. 13838-00-AMA-17-C

Sheet No. ____ of ____

Drawing No. ____

Computed by DWM Checked by JGW Date May 29, 1991

Resultant Location $\Rightarrow \frac{\Sigma M}{\Sigma V}$

Case I

$$\text{Location} = \frac{.75(14.111) + 22.125(9.63) + 0.101(.439) + .733(.151) - .606(9.94) - 4.667(6.125)}{0.75 + 22.125 - 8.104 + .101}$$

$$= 7.78 \text{ FT}$$

Case II

$$\text{Location} = \frac{22.125(9.68) - 0.101(.439) + .733(.151) - 6.06(9.94) - 4.667(6.125) - 5(14) + .75(14.111)}{22.125 - 8.104 + .101 + 0.75}$$

$$= 3.08 \text{ FT}$$

Case III

$$\text{Location} = \frac{22.125(9.68) + 6.172(1.667) + 1.753(5.8) - 12.757(5.897) - 14.656(9.701) + .750(14.111)}{22.125 + 6.172 - 14.656 + .750}$$

$$= 1.957 \text{ FT}$$

Case III

$$\text{Location} = \frac{22.125(9.68) + 2.132(2.323) + 3.125(3.333) + .75(14.111) - 14.783(6.255) - 16.752(7.094)}{22.125 + 2.132 + .750 - 16.752}$$

$$-.409 \text{ FT}$$

APPENDIX G

BACKGROUND DOCUMENTS

No Background Documents
Were Available For This Dam

END

DATE
FILMED

11-81

DTIC